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Compressed Air

A MONTHLY MAGAZINE DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

VOL. VIII. NEW YORK, MARCH, 1903. NO. 1.


The Advance Agent of Civilization
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Compressed Air.

OR

THE COMPRESSED AIR MAGAZINE.

A MONTHLY PUBLICATION DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

W. L. SAUNDERS, - Editor and Proprietor
J. E. QUINTERO, - } Associates
M. E. VARIAN, }

Subscription, including postage, United States, Canada and Mexico, $1.00 a year. All other countries, $1.50 a year. Single copies, 10 cents.

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Those who fail to receive papers promptly will please notify us at once.

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VOL. VIII. MARCH, 1903. NO. 1

Another Year for Compressed Air.

With this number we begin the eighth volume of COMPRESSED AIR. Previous volumes are completed and speak for themselves and it is hoped to make the coming volume more complete and valuable than those already issued. Starting at a time when the possibilities of air under pressure were beginning to be appreciated, COMPRESSED AIR has endeavored to chronicle each step in advance.

Important as the general subject is, it does not warrant a large publication. For this reason COMPRESSED AIR has purposely refrained from an expansion which would mean the publication of a large amount of matter more or less foreign to the subject. It makes no attempt to occupy a position other than the mouthpiece of those manufacturing or using compressed air machinery in one manner or another.

Since its first issue an earnest effort has been made to report the discoveries and advances in the science of compressing and using air, and the practical application of this medium in the shop, factory and elsewhere. To do this it has been necessary to abstract material from other general technical journals, from papers read before Engineering Societies and from all sources where suitable material or anything likely to be of practical value or of especial interest could be obtained. To this has been added contributions from papers, discussions and correspondence from subscribers and others, the whole being supplemented by timely editorials purposely made brief and intended only to call attention to the salient features of more practical articles.

The first five years have recently been printed in one volume of about 1200 pages, entitled "Compressed Air Information," and this has enabled us to supply a complete file to many of the new subscribers, who in this way have had at hand for reference, practically all of the important contributions to the branch of science and engineering included under the term of compressed air.

For all articles from contemporary publications we have at the time of publication given credit, but we take this occasion to thank our friends among the technical journals for the courtesies extended to us. Throughout the ensuing year the same policy will be maintained and an effort will be made to collate everything bearing on the subject, that our subscribers may have a cyclopedia of compressed air information.

Power Transmission Using Belt and Rope.

BELT DRIVES.

From time immemorial belts have been the most common form of transmitting power from shaft to shaft. In spite of this fact, the principles of belt driving are but rarely thoroughly understood to-day. The transmitting power of any belt is dependent upon the following points:

1st—The number of feet per minute travel.

2d—The tension under which it is run.

3d—The number of degrees of contact which it has with both the driving and driven pulleys.

4th—The width and thickness of material used in its manufacture.

In addition to these points a number of varing conditions enter many drives that must be taken into account for the particular drive to be considered.

Possibly the most common error of engineers is their failure to appreciate the importance of speed or feet per minute travel of belts. By this statement I do not mean necessarily the high rotation of shafting; although slow speeds can often be profitably increased, I suggest a simple way of obtaining the same result, the speed of the shaft remaining the same. If we double the speed of a belt we double its transmitting power, or a belt of one-half the width will deliver the same power at the increased speeds.

The principle expense in belt driving is the belts themselves. If by simply increasing the diameter of the pulleys, the width of the belt and therefore its cost, can be halved, a considerable saving has been affected. The cost of the increased diameters of pulleys is partially offset by their reduced widths of face and the total saving made is large or small in accordance with the size of belt required.

It should be borne in mind that while increase in speed is advantageous, a point is eventually reached beyond which it is a dead loss to venture. Above 5,500 feet per minute centrifugal force increases to such an extent that it tends to throw the belt away from pulleys and it is not practical to place a sufficient strain on the belts to resist this force. Belts are often run at higher speeds than I have noted, but other considerations enter the case, and no increase of power results after exceeding the maximum figure named.

The usual running tensions in ordinary mill practice for first quality single, double and heavy double leather belts are 60, 80, and 100 pounds per running inch of width.

A few rules that experience has taught and with which every engineer should be thoroughly conversant follow:

Always place a tightener upon the slack side of the belt.

Run the slack side of the belt on top if possible.

Keep belts clean.

Treat with some approved dressing as often as required to keep soft and pliable.

Place grain side of belts next to pulleys.

Place idler pulleys on slack side of belts so far as practicable.

The smaller the pulley over which a belt runs the shorter its life; the constant sharp bending of the fibres wears it quickly.

Avoid single belts of great width. Doubling the thickness of belts does not double the power they transmit.

Do not run light double belts over pulleys less than 18 inches diameter, heavy double over less than 36 inches diameter, and triple over less than 60 inches diameter, if possible.

Make belts endless if practicable and provide means for taking up slack.

Avoid belt hooks; they are particularly hard on wood pulleys, as well as belts.

Never forget the loss from slippage by belts.

In accurately figuring speeds of pulleys belt slip should be considered. It amounts in general practice of from two to three per cent.

Belt drives with as nearly even diameters of pulleys as practicable give best results. Use wider double belts in preference to triple belts. A belt invariably climbs to high side of pulley.

ROPE DRIVES.

There are two systems of rope driving in use at the present time. One, having a separate rope for each groove in the drving and driven sheaves and known as the English system, and the other having one continuous rope for any number of grooves and known as the American system. A fair and just comparison of its merits with the English system, and belts, is interesting and of value to every engineer. Taking up the English system we

find that each rope is separate and distinct from every other rope on the drive. Each rope requires its own splice. No two ropes can be spliced either in or out of the grooves under an equal tension. This may be verified by noting the different points to which the various ropes sag. Beside this primary tension due to splicing on tightly, and which amounts to nothing as soon as the ropes stretch, each and every rope is dependent for its tension upon the weight of the rope between the driving and driven sheaves. To partially overcome this difficulty a steeper and sharper angle for the sides of the grooves is adopted. The grooves are also made very deep in order that the ropes may not jump out. Owing to the uneven tension on all the ropes it is evident that a few of the tightest must do the work for which the whole number were first considered necessary. The few ropes are largely overloaded while the balance are not doing their share of the work. The overloaded driving ropes thereupon quickly stretch out and as soon as they do so the remaining ropes take their share of the load, but having stretched to practically no extent before, they now stretch to a great extent under the increased load imposed, and the load is thus shifted back onto the few originally light and overloaded ropes. As a consequence of this severe strain they soon wear out and new ropes must be spliced in place. The new ropes, of course, easily stretch, and the load must then be borne by the tightest of the old remaining ropes. Thus we see the same cycle of events continually recurring and the majority of the work being done by a few ropes alone. Owing to the unevenness and lack of tension a large number of ropes are needed for any given amount of power. This means heavier sheaves and heavier shafts, couplings and bearings for their support. These heavier shafts and sheaves mean increased friction upon the bearings, and, therefore, more power to overcome the friction load alone.

English rope transmissions are only successful for straight open drives. They do not permit of complicated turns and angles. They are not successful with small diameters of rope, and, therefore, large diameter sheaves must always be used.

As compared with this style of rope driving the American system has the following points of advantage. It has but one rope, and, therefore, one splice for any number of grooves within good engineering practice. The ends of the rope which stop on opposite sides of a sheave when a drive is completely wound, are brought together by means of a single groove tightener sheave set in an automatic take-up carriage. This tightener is set at an angle equal to the cross or distance between the two outer grooves of the driving and driven sheaves on any drive. By means of weights attached to the tension carriage the slack is automatically removed from the rope, and an even and known amount of tension is kept upon all the ropes at all times.

The carriage automatically adjusts itself to the amount of power to be transmitted at any given time, and as the amount of tension is controlled by the amount of weight used, it can at all times be adjusted to the requirements of the drive. Having a fixed, even, and known tension upon each wrap of rope the amount of power that one or more wraps will transmit can be readily determined.

As compared with belt drives the rope required is many times cheaper than belting and the sheaves cost somewhat more than pulleys. There is no slippage, however, and for cotton and woolen mills requiring a steady, even load and a uniform speed the American system is superior to belts. The friction load, as numerous tests have proven, is less with this rope method than with belting, and the amount of space required is only 60 per cent. of the width of belting required for an equal amount of power. Belts are under only such tension as the experience of the operator deems best to put on the tightener, if any tightener be fitted to the outfit, while the ropes are a tension at all times automatically adjusted.

The life of the average rope is about two and one-half to three and one-half years; under exceptionally favorable conditions it will last longer. Its small cost, however, makes it but a small item as compared with belts, and the amount of capital required for the purchase of rope is not tied up as in the case of the large first cost of the belt. A separate belt is usually required for each line of shaft to be driven. By means of the vertical and horizontal drop-off system a single rope will drive a number of shafts upon different floors or upon the same floor. The

total space required by this method is extremely small and is many times less than that occupied by belts. In this connection it is usually cheaper then belts. For transmitting power to long distances the rope drive stands alone. It runs out of doors and by means of idler towers can be carried for long distances.

As compared with an electrical outfit the American system of rope transmission is at the present time far more economical. The use of motors is claimed to give a steadier and more even speed. This is not proved by experience. The rope drive has always shown that it will transmit power in an absolutely even and steady manner. This can easily be explained by the fact that the ropes absorb vibration and load variations, since they are not a rigid connection and the slip is inappreciable.

The cost of a rope drive and an electrical outfit, each to transmit the same amount of power, is about in the ratio of three to one in favor of the rope.

A rope drive is the easiest transmission known, upon an engine. Engine manufacturers who have tested the matter thoroughly admit this fact, and advise this form of connection. It is as easy to use a grooved fly-wheel as a band fly-wheel, and, as already noted, the space occupied by the grooved wheel is much less. The loss of power transmitted in simple belt drives amounts to from six to fifteen per cent. when the belts are under ordinary tension. When they are tightened excessively, the friction loss on bearings, etc., is much greater. The English system of rope transmission has the same friction losses as belting and is figured upon this basis. In the American system the loss is less than with either the English system or belts, and as nearly as can be estimated amounts to from three to eight per cent. in accordance with the design of the drive.

The average friction load of cotton and woolen mills varies between twenty-five and thirty-five per cent. Upon a basis of twenty-five per cent. this would be divided up as follows:

Six per cent. for the engine.

Eleven per cent. for shafting and main belts.

Eight per cent. for shifting belts, tight and loose pulleys and machine connections.

This is upon the basis that the mill is belt driven throughout. For an electrical outfit the percentage of loss is as follows: If engine loss is six per cent. in any case ninety-four per cent. of the indicated horse power remains for driving the generators. Under very best conditions the generator has an efficiency of ninety per cent., or 84.6 per cent. horse power of each one hundred indicated horse power would be delivered to the line wire, and, in addition, the friction for a direct connected engine would be greater than for a mill engine, owing to the increased weight on engine shaft; larger shaft and greater distance between bearings. Mill loss between generator and motor would be about two per cent. This gives us 83.9 per cent. indicated horse power delivered to motor. The motor loss would be so great if not more than generator loss. Upon this basis the motors deliver to line shafting 75.51 per cent. of the indicated horse power. In other words, in the substitution of motors and generators for belts or ropes and main head-shafts in a mill, we have a greater loss than occurs in ordinary cotton or woolen mill practice. We have still ignored the friction loss by shifting belts, line shafting, and other machine belts.

Taking our above figures we find that 62.51 per cent. of the indicated horse power is delivered to machines as compared with the 75 per cent. of the indicated horse power with belts or ropes. Losses in transformers, etc., have not been considered, but an appreciable loss occurs through their use. The cost of operation is also greater, as an electrician must be employed. The repairs on electrical apparatus are the most expensive of any class of machinery. If individual motors are used for each machine the above cost would be so great as to be totally impracticable. The above figures are based upon the use of an independent motor for each or every two line shafts and belting or direct connecting to these shafts.—F. H. Underwood, M. E., in *Power and Transmission*.

Graphite as an Air-Brake Lubricant.

Quite exhaustive experiments have been conducted at Purdue University, under the direction of Prof. Goss, to determine the effects of lubricants on the sensitiveness of triple valves. The experiments were conducted on an airbrake rack which embraces a full equipment for two trains of

fifty cars each. All piping, valves, fixtures, etc., which would be used on an actual train of cars, has a place upon this rack. The rack was designed and is now maintained for the purpose of determining the action of triple valves used on freight cars which are interchanged from one road to another. Accessory to the rack is a chronograph, and all necessary gauges for determining the precise time of action of every brake.

The controlling mechanism of the air-brake system is the triple-valve, of which there is one for each car composing the train. It is the triple-valve which, responding to a reduction of pressure in the train-pipe, brought about by the engineer, permits air from the auxiliary reservoir to pass into the brake cylinder, thereby applying the brakes. It is the triple-valve, also, that responds to an increase of pressure in the train-pipe, and in so doing exhausts the brake cylinder and re-establishes connection between the auxiliary reservoir and the train line releasing the brakes. The mechanism of the triple valve is necessarily delicate and nicely adjusted. Its wearing parts are of brass, and as the pressure imposed upon its rubbing surface is light, it was thought that all conditions were favorable to the use of graphite alone as a lubricant.

A test of triples, showing well their responsiveness to changes in pressure, is one which has come to be known as the "skipping test." It is well known by those familiar with air-brake performance that the brakes upon certain cars of a train may be cut out of action without interfering with the action of the remaining brakes. If, however, too large a number of brakes are cut out, or if they are grouped too closely together, then it becomes impossible to secure an emergency application on those brakes which, counting from the engine, are beyond the cut-out group. For example, in the rack under consideration, it is found that when triple valves are lubricated with vaseline, it is always possible in a thirty-car train to cut out alternate groups of two throughout the length of the train, without interfering with the emergency action in those brakes which are left in service. When the valves are in good condition, and if the three following the engine are left in service, it is possible to cut out alternate groups of three; the exact number of cut-outs in any train always depending on their grouping. It is by means of this delicate test that it was proposed to test the value of graphite.

The process of conducting the experiments under consideration consists in cutting out brakes in certain well-defined groups, and in making application; after which an additional brake or two will be cut out, the application repeated, and so on until a limit is found for which an emergency application fails on the brakes in the rear of the train. In preparation for the test, all triple-valves in the rack were taken apart, wiped and thoroughly cleaned, lubricated with dry flake graphite, and restored to their places in the rack.

On starting the air pump in preparation for the test it was found impossible to secure a pressure on the train line of more than forty pounds. It was found also that there was a constant blow of air from the exhaust of every triple on the rack. This was thought to be due to the presence of graphite between the slide-valve of the triple and its seat, which would raise the valve a sufficient amount to cause the leakage to be observed. Believing that a few movements of the slide-valve would bring it to its seat and thus stop the leak, repeated emergency applications were made. On first trial only the one brake nearest the engine went into quick action, but after repeated trials all ten brakes involving a ten-car train were made to work successfully. After this, other brakes were added by twos until an emergency could be had on a thirty-car train, and after six applications were effected by exhausting the train line from the valve of the fiftieth car at the rear of the train, a full fifty-car train would respond in an emergency application. This preliminary work involved fifty or sixty applications for those brakes which were near the forward end of the train, and not less than fifteen for those triples which were subjected to the fewest number of applications.

The valves having in this manner been made tight, the formal skipping test was undertaken, first on a fifty-car train, next upon a thirty-car train. Alternate twos could be cut out either with the first two in or out, but in the thirty-car train, action could not be depended upon if the first two were cut out. With alternate threes cut out, the first three being in, the emergency was obtained upon the sixth car of the fifty-car train, but no emergency could be obtained on the thirty-car train.

The attempt to cut out alternate fours, the first four being in, gave emergency on the first four only, both in the fifty and thirty-car train.

Repeated experiments served to show that two consecutive brakes could be skipped with certainty at any place upon the train, both when fifty cars and thirty cars composed the train. Three cars could be skipped in the middle of fifty; two in the middle of thirty and one in the middle of a fifteen-car train.

The time record, as obtained for each test, shows the valves to have been slower in action with graphite than under normal conditions. For example, the time lapse between the application of the brake on the first car and that of the last car of the fifty-car train was three and one-half seconds longer when graphite was employed than under the usual conditions with vaseline, the facts in this record being as follows:

	Graphite.	Vaseline.
Seconds between time of action on first car and time of action on the last car of twenty-five car train	13.5	12
Seconds between time of action on first car and time of action on the last car of fifty-car train	28.5	25

Upon the conclusion of the tests with graphite, as described in the preceding paragraph, the triples were again taken apart. In this process it was discovered that the slide-valve of some of the triples was so firmly held to its seat that it could only be moved by the use of a lever of considerable length. The usual freedom of motion which characterizes several parts of the triple had in many cases quite disappeared. No evidence of damage appeared in any valve, and no surplus graphite was found. Having been thus taken down, the several parts of the triples were well vaselined and, having been re-assembled, the triples were restored to their position on the rack. Following the restoration of the triples, the schedule of tests previously run was in part repeated, whereupon it was found that the action of the triples was more delicate than has ever been shown to be before. The record shows that they were more responsive to skipping tests and the time of action was shorter than in any previous tests made upon them. The important conclusions of the test may be stated as follows:

1. Graphite alone is not a sufficient lubricant for triple valves.

2. After graphite has been well rubbed into the working surfaces of the valves, and after this process has been followed by thorough oiling with vaseline, the action of the triple valves is more delicate and more rapid than with vaseline alone, prior to the use of graphite.

3. The presence of the graphite on the metal surfaces of the valves, when operated with vaseline as a normal lubricant, serves to improve their action in a marked degree.—*Graphite.*

Rand Deep Level Temperatures.

When discussing the increased cost which deep level mining involves, the liability of encountering temperatures detrimental to economical working is one of the fair factors which demand consideration. It is, of course, included in the more general problem of the amount of ventilation required; but, on the other hand, if it be known definitely wnat temperature would be encountered at a given depth one more factor of uncertaintv is eliminated, and the amount of air necessary for the ventilation, apart from the refrigeration of the mines, would alone remain to be determined. It seems the more desirable to determine this question, owing to the wide varieties of opinion which have from time to time been expressed as to the range of geothermal gradient in different parts of the world and the failure to substantiate exceptional results in the face of accurate investigation. Temperatures are, of course, investigated under conditions which differ widely, both as regards the practicability of close observation and the experience of the observer. Naturally, the data taken from boreholes is more reliable than what is obtained in shafts—observations which can hardly be of more than relative value, depending greatly on the amount of ventilation, machinery, exhaust from condensers, explosives, lights, the temperature of the air delivered into the mine, and many other conclusions which render observations conducted in shafts practically valueless for anything like general and exact conclusions. In the case of bores, on the other hand, the smallness of the

aperture renders the thermal disturbance from above improbable, and the possibility of plugging the bore itself makes it possible to isolate each temperature level from the influence of those above and below it. Again, in the case of boreholes, not only have we the possibility of accurate observations at great depth by means of an overflow thermometer, but also the fact that such observations have been actually made at depths practically double those reached in any mine. In any general estimate of temperature, therefore, for future workings such as is now necessary in the case of the Rand, it would be well not to rely on shaft observations. What, then, may be taken as the ordinary increment of temperature with increasing depth? Professor J. D. Everett, Chairman of the Standing Committee appointed to investigate the rate of increase of underground temperature, in a lecture delivered some two years ago, states that "the gradients of temperature vary between 1° F. in 40 ft. and 1° F. in 80 ft., the best average being about 1° F. in 60 ft. Gradients steeper than 1° in 40 ft., or less steep than 1° in 80 ft. are sometimes met with, but are very rare." The three deepest as well as the most carefully conducted series of experiments to determine temperature were made at the boreholes, at Paruschowitz, in 1893, when an observation was obtained at a depth of 6,427 feet, at Schladebach, where a depth of 5,630 ft. was observed, and at Sperenberg, where the depth observed was 4,172 ft. The gradient observed in these three cases, when the surface temperature had been corrected, was: At Paruschowitz 1° F. in 58.3 ft., at Schladebach 1° F. in 65 ft.; while in the third instance the gradient is variously given as identical with that of Schladebach and as 1° F. in 51½ ft. Other well-known bores which may be mentioned are an oil well of 4,800 ft. at Wheeling, in Virginia, which gave 1° F. in 74 ft.; a well of 2,733 ft. in Sydney harbour, 1° F. in 80 ft.; and the Rand Victoria borehole, 1° F. in 82 ft. In Victoria, according to Mr. Jenkins, late Government Metallurgist, the rate of increase is 1° F. in 80 ft. Though these observations extend over localities widely separated as well as geologically distinct, their general agreement makes it difficult to accept without reserve the highly favorable estimates which have been put forward for deep level working on the Rand, especially since the highly exceptional figures at one time advanced for the Calumet and Hecla, the deepest mine in the world, have been withdrawn in favor of a figure more or less in consonance with the foregoing results. The most recent instance of such an estimate was that put forward by Mr. Leggett, in the discussion of the paper of which he and Dr. Hatch were the joint authors, and which was recently reported in these columns ("M. J.," 1902, p. 1581). Mr. Leggett there spoke as if the rate of increment had been definitely observed at 1° F. in 206 ft., and it may be that opportunity has been taken of some of the recent deep bores to make observations of which this is the result. But if this is the case, the results will certainly come as a surprise to scientific observers in this department, and it is remarkable that no authority was given for the statement. The opportunities which present activity in boring presents should not be lost. Some doubt has been thrown on the exactness of the Rand Victoria results, but if they are inaccurate this emphasizes the necessity for obtaining reliable data, and in any case confirmation of single observations is always desirable. Until such observations are obtained, however, the conservative will prefer to accept the results arrived at by Mr. Hamilton Smith at the Rand Victoria borehole, which, allowing for the higher surface temperature of the Transvaal, assumed to be about 70° F. compared with that in Germany, gave results not incommensurate with these more extensive experiments. The difference in working conditions involved by the estimates of the two authorities at 5,000 ft. would be something like 130° F. as compared with 94° F. Of course, it is not suggested that the higher figure would prove in any way insurmountable, but it would undoubtedly sensibly affect the question of expense. If the best results are to be obtained from miners, that is to say, if highly paid labor is to be economized as much as possible, the temperature should be kept down at least to 80°, and that means that the allowance necessary for ventilation alone must be greatly increased if the higher rather than the lower estimated temperature should prove correct. Now the amount of ventilation requisite will determine the size of the shafts which have to be sunk, and it would be interesting to know to what extent provision has been

made to meet this unknown quantity of possibly high temperature, the existence of which Mr. Jennings has so definitely pointed out. There can be little doubt that at the present time the ventilation of many of the Transvaal mines is, judged by English standards, defective, and in the recently issued report of the Transvaal Mines Department it is pointed out that the miners are dependent for their supply of fresh air required by the mining regulations on the exhaust from rock drills, and that "in many cases no precautions are taken to insure that pure air shall be supplied to the drills. On the contrary, many of the cylinders of the compressors are lubricated with oils of low flash point, which, under the combined influence of heat and pressure, take fire. The result is that the products of this combustion are forced into the mine, and thus, instead of the ventilation being increased, it becomes impossible for the miner to work his drill in a confined place, owing to the suffocating gases emitted." The lamentable amount of disease prevalent among the miners, both black and white, comprising phthisis, pneumonia, enteric, dysentery, scurvy, and recently leprosy, are proof that a disregard of the laws of health cannot be persisted in with impunity; and with labor comparatively scarce, as it now is, this fact will have to be recognized. De Beers mines, with some 12,000 employes, have apparently not experienced the same difficulty as the Transvaal in maintaining a full complement, which looks as if native labor would be forthcoming if conditions were sufficiently attractive. To quote the words of the manager of the Crown Deep with reference to the general comfort of the boys, "If bread was given with coffee in the morning and more money spent in housing, feeding and clothing the boys, I think it would prove the most sensible way of settling the native wage question." Unless every forethought is exercised in making the conditions of employment as tolerable and healthy in deep level mines as in outcrops, it appears likely that new propositions will always have the call of labor, while the great deep level propositions will be continually in want.—*Mining Journal,* London.

The Production of Low Temperatures.

It was not very long ago when the experiment of freezing mercury, as performed in physical laboratories, was considered quite remarkable. To-day, however, it is not so looked upon; and the physicists have shown us that by the judicious use of liquefied gases extremely low temperatures in the neighborhood of 200 deg. Centigrade (392 deg. Fahrenheit) below zero can be obtained without very much trouble.

If, however, theoretically, no man of science ignores the fact that such extreme intensity of cold can be produced, many, on the other hand, practically, find it materially impossible to produce them.

Contrary to what one would suppose, nevertheless, it is not extremely difficult to obtain very low temperatures with ap-

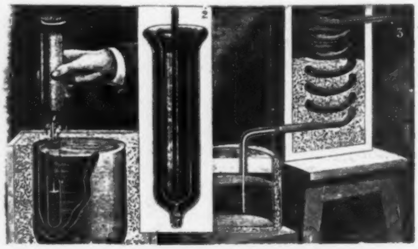


FIG. 1—1. FREEZING GASOLINE BY LIQUID AIR.
2.—TUBE OF LIQUID AIR.
3.—APPARATUS FOR VOLATILIZING CARBONIC ACID DISSOLVED IN ACETONE.

paratus easy to procure. As Prof. d'Arsonval demonstrated recently at the Academy of Sciences, with certain judicious precautions, one can easily produce temperatures between —60 deg. C. and —195 deg. C. (—140 deg. F. and —383 deg. F.).

Thus, if some chloride of methyl be placed in a porous receptacle, by its simple and natural evaporation through the sides of the vessel, the temperature will reach 60 deg. C. below zero. With carbonic acid or acetylene, it is easy to obtain temperatures ranging from —112 deg. C. to —115 deg. C. (—233.6 deg. F. to 239 deg. F.) To do this, acetone which has been previously cooled is made to absorb carbonic acid or acetylene snow,

either of which may be easily obtained at ordinary temperatures and varying pressures by opening a cylinder containing liquid carbonic acid or acetylene. The cold produced by the sudden evaporation of a part of the liquid mass, lowers the temperature sufficiently to transform the rest of this mass into a snow which, left to itself, then slowly melts. The snow is caught in a napkin, rolled up in the shape of a cone, into which the jet of carbonic acid or acetylene is directed from the cylinder containing the liquefied gas. This snow, especially that derived from acetylene, is very soluble in acetone. At—80 deg. C. (—176 deg. F.) acetone will dissolve more than 2,500 times its volume of acetylene. The snow, in dissolving, will lower the temperature 20 deg. C. further, and, if the acetone has been sufficiently cooled beforehand, this will bring the final temperature down to —115 deg. C.

The method pursued by M. d'Arsonval for obtaining by this process the lowering of the temperature to —115 deg. C. is as simple as it is ingenious. It consists in hastening the evaporation of the carbonic acid or acetylène snow, by a suitably cooled current of air. For this purpose, he makes use of a double coil of tin pipe obtained by inserting in a piece of pipe 10 millimeters in diameter and 10 meters long another pipe of the same length, but only half the diameter, and then rolling the two into a spiral, after which they are packed in a wood box stuffed with wool to prevent exterior radiation.

The upper end of the small pipe is connected to a blower and the lower end is introduced into the bottom of the solution of snow-acetone, while the upper end of the large pipe opens into the air and the lower end passes in through the stopper of the vessel containing the solution. The air that is blown in through the small pipe passes through the volatile liquid and produces very rapid evaporation—evaporation which is accompanied, naturally, by an enormous absorption of heat. As a result of this, the gases that are disengaged are at a very low temperature. But these cold gases must make their exit through the large pipe which incloses the small, thin, tin one through which the air was drawn in. Therefore the entering air is cooled economically by the gases of evaporation before it reaches the mixture of snow-acetone.

For temperatures still lower than 115 deg. C. below the melting point of ice, recourse must be had to liquid air, which can now be easily produced by the Linde process. The following is the method pursued in obtaining these intense degrees of cold that it is possible, moreover, to maintain perfectly constant.

The liquid air is placed, in order to avoid its rapid loss by evaporation when exposed to the air, in a closed vessel that is as impermeable as possible to heat—a vessel consisting, as is generally known, of a double casing of silvered glass in a wool lined box.

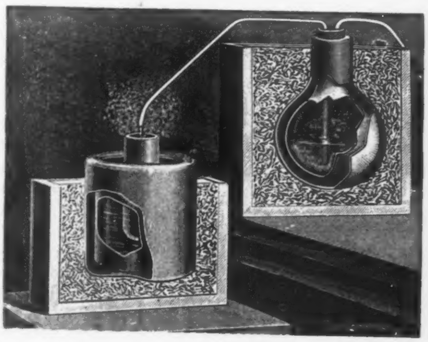


FIG. 2—ANOTHER METHOD OF FREEZING GASOLINE BY LIQUID AIR.

In another silvered, double walled vessel, likewise packed in a box in wool, some gasolene is placed. This liquid, if it has been made in the usual way, is capable of resisting without congealing a temperature as low as —194 deg. C. (—317.2 deg. F.), which is that of ebullition of liquid air under the normal pressure. Into this bath of ether, which constitutes the medium to be cooled and to be maintained at a constant temperature, a sort of test tube of thin copper is introduced. If the experimenter then forces the liquid air through this tube and causes it to fall drop by drop into the vessel surrounding it, by the evaporation of this air he will obtain a cooling of the gasoline which may be maintained constant if the flow of liquid air is suitably regulated. For this, M. d'Arsonval uses two different arrangements which are equally simple. The first consists in employing as a reservoir for the liquid air a double walled flask closed by a cork

through which two tubes pass. One of them goes to the bottom of the flask, so that its end is below the surface of the liquid air. The other, which merely passes through the stopper, terminates in a rubber bulb. By squeezing the bulb, and thus exerting a pressure on the volatile liquid air in the flask, the latter is forced in small quantities through the outlet tube which leads to the small metal cup inside of the vessel contaning gasoline. The apparatus is nothing more or less than an application of the pipette of the chemist.

The other arrangement, which is perhaps even more commodious, consists of a double walled glass tube terminating at the bottom in a small pipe, the flow of liquid air through which can be regulated by a vertical glass needle.

By following the above described methods of M. d'Arsonval, great intensities of cold can be obtained without using an excessive amount of liquid air. "With cylindrical silvered vessels of about a liter in capacity," says the illustrious physicist, "the loss of heat by exterior radiation at —194 deg. C. can be reduced to 20 grammes of liquid air per hour—a very small quantity, as will readily be seen, and one that will make the employment of liquid air quite practical." —Translated for the *Scientific American* from *La Nature*.

A Small Hydraulic Installation.

For some processes of manufacture, nothing is superior to hydraulic transmission, but the cost of installing it deters many from using it who should do so.

Where I am employed they put in a hydraulic press operated by a direct-acting steam pump which pumped the operating fluid directly into the press cylinder without an accumulator. Of course, in time it became necessary to put in additional presses, and as the direct-acting method of operating had not been fully satisfactory, it was decided to put in a complete hydraulic system with an accumulator. The cost of a pump of suitable capacity was moderate, but an accumulator of sufficient size, of the weighted type, with its safety valves, etc., was expensive and objectionable on account of the space required and the expense of keeping it in good operating order.

The steam-hydraulic accumulator was duly considered, but it also was expensive, and seemingly costly to operate on account of loss by condensation and wear of packings. The variety of work done on the presses was such that it was desirable to use pressures from 500 to 2,000 pounds per square inch at will, and if the system would permit of easy adjustment to the pressure needed there would be considerable economy in operation. One very favorable feature was that a 10 per cent. variation in pressure from the desired point was permissible.

All this pointed to an air accumulator as being the ideal thing for the conditions, but I was unable to learn of any precedent of use with such heavy pressure as 2,000 pounds. Yet there seemed to be no particular reason why it would not work successfully.

For the accumulator a steel bottle 14 inches diameter and 7 feet long was ordered, but for some reason the firm who took the order, after a long delay, offered as a substitute a bottle 9 inches diameter, 10 feet long. As one of this size was too small, it was necessary to get two of them. They were set vertically, close together and connected top and bottom so that they acted as a single one.

In this kind of accumulator, it is necessary to have some means of showing how much, or at least when there is enough, water in it; for if the water is all drawn out and air escapes into the presses, it is a permanent loss of pressure which requires special means of restoration. Of course, a sight gauge was the thing wanted, but a sight gauge that will stand 2,000 pounds per square inch is not a common article. Various substitutes, magnetic and mechanical indicators, were thought of, but none of them seemed practical or reliable, so it was decided to make peep sight gauges.

The accompanying drawing shows the construction of one of them. The sights are plate glass 11-16 inch thick and the metal is brass. It has frequently stood a pressure of 2,500 pounds per square inch without failure. One glass was broken, but that was not due to the working pressure, it being caused by improper setting of the glass in the gauge.

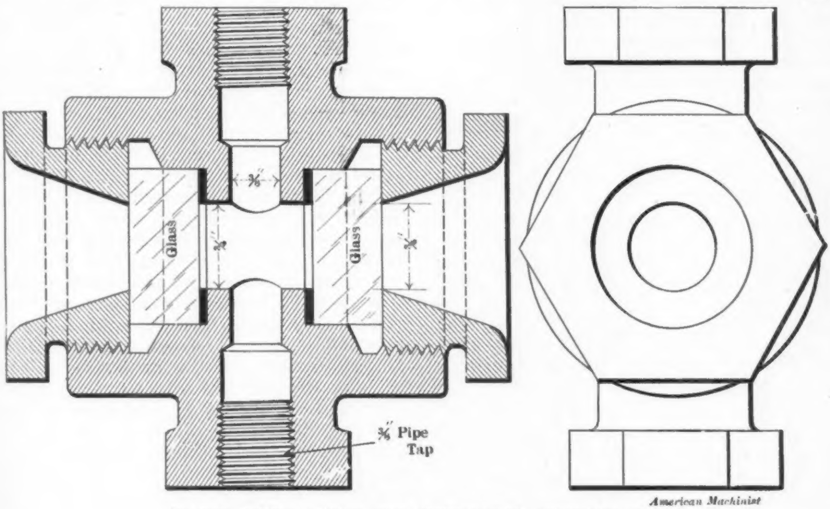
It is important to have both surfaces of the glass flat, smooth and parallel. It is also safer to have a tough paper ring

between the screw gland and the glass, so that when screwing down tight it will prevent the metal from grinding on the glass. This packing ring under the glass is leather.

Two of these gauges were used, connected by 3/8 inch heavy pipe with the top and bottom of the accumulator, one being located in the pipe 4 feet below the top and the other 5 feet below that. When working the water is supposed to be kept between them and especially not allowed to get below the lower one. Just below the lower sight is the connection to a pressure gauge. At the top and bottom of the vertical gauge pipe angle stop valves are placed, the upper one having a chain wheel on it with the chain coming down to a

pipe was tapped having on it a throttle valve.

To pump air the air pipe was left open and the water suction pipe was throttled to allow enough water to go with the air to seal the valves. It was found that 300 pounds was the highest air pressure that could be obtained by this method. To get a higher pressure an air pump 3 inches diameter and 6 inches stroke, single-acting, was mounted and driven by a crank on the end of the pump shaft. This pump had a suction pipe to the tank and the air pipe was placed in it, and the discharge pipe was run into the suction pipe of the triplex, making a compound air pump. The mixture of air and water is pumped till the accumulator is filled to the upper



WATER SIGHT GAUGE FOR HYDRAULIC ACCUMULATOR.

convenient height so that the valve can be shut quickly should a gauge fail under pressure. The two bottles are connected at the bottom by 1½-inch pipe and to this the pump pipe and press pipes are connected.

A triplex single-acting belt-driven pump 1¼x5 inches was installed for operating the system. It was necessary to charge the accumulator with air pressure of 300 to 500 pounds when the water stood at the lower gauge. The tank from which the pump drew its supply of water was placed so that the fluid would flow into the pump by gravity. Into the suction pipe an air

gauge, when the water is drawn down to the lower gauge. This is repeated until there is enough air to produce the required pressure when at the lower gauge.

With the pump running 100 revolutions per minute, it takes 3½ to 4 hours to get up 500 pounds air pressure. It requires some experience to find how much water must be let in with the air to get up the pressure in the least time. In operation there is a gradual loss of air, probably partly from leakage and partly from absorption by the water, and this loss is supplied usually whenever the system is idle.

To get automatic control of the pump when in regular operation a belt-shifter was used, which was operated by a plunger actuated by the pressure in the system, which stopped the pump when the pressure got too high. The plunger was ⅜ inch diameter and was weighted with removable weights, which were changed to suit the pressure required.

This is not a satisfactory plan of control, and it is better to have the pump run continuously and control the pressure by having a switch valve in the pump discharge pipe, operated by the controller plunger, so that when the pressure reaches the maximum point it will lift the valve and allow the water to discharge back into the supply tank or the pump suction pipe. It is of course necessary to have a check valve between the switch valve and the accumulator, so that the pressure will not force water back through the switch valve.

More pumping capacity was soon required, and a duplex, direct-acting steam pump, 14—2x10 inches, was put in. To control this pump it was decided to put a throttle controller on the steam pipe to be actuated by pressure from the accumulator; but it was discovered, when corresponding with makers of pump regulators, that a Mason differential pressure regulator would give complete control, the pump itself serving as part of the controller. The standard Mason regulator was used and the screw adjustment of it proved to be sufficient to get any pressure from 500 to 2,500 pounds in the accumulator, and it is so sensitive that a fall of 20 to 30 pounds in the accumulator starts the pump. This pump will not pump air, and the air charging is still done with the triplex pump. It will be observed that the accumulator is in fact nothing but a large air chamber for the pump, provided with a means of charging it with air. It is very interesting to watch how promptly the steam pump responds to the demands of the presses, and where some variation in the working pressure is allowable this system is so good that it may be adopted with entire confidence in the results. In operation there has been found no need for safety valves on the pipe lines, as they are all comparatively short, and of course the accumulator does not need one, as the air pressure is perfectly elastic and without inertia.

I have spoken of water being used in the system, but a partly refined grade of petroleum is really used instead of water. This, however, is a possible source of danger, and it was with some doubt that I watched the first charging of the accumulator, because an air pressure of 2,000 pounds on top of oil, and at a sufficient temperature, would be a combination for producing a first-class gas explosion. However, the air pressure accumulated so slowly that the heat had time to radiate.

When the pressure is changed from 500 to 2,000 pounds it is done very quickly, but it does not increase the heat enough to seem near the danger point. In case of a fire there is no doubt that a very bad explosion would result as soon as the heat reached the right point, and where oil is used it would no doubt be best to have a valve on top of the accumulator, which would let off the air when the heat reached a given point; something like the automatic sprinklers used in buildings to put out incipient fires.

In hydraulic systems it is an advantage to keep the working fluid free from all matter large enough to lodge in the pump valves and cause trouble, and we tried to do this by putting a strainer on the suction pipe inside the tank, but this was frequently troublesome, on account of getting clogged so that the pump could not get its supply. To overcome this a special tank was made, of a rectangular shape and of a width one-half the length. Across this, in the middle, is a partition which reaches from the top to within an inch of the bottom.

About 1½ inches above the bottom, in one end, a brass cloth screen is located, which is easily removed, as it rests on angle-irons around the inside of the walls. All the discharge pipes from the presses project just through a cover on this end of the tank. The discharge from the pipe keeps the oil in rapid circulation above the screen and prevents it from clogging, and as it is easily removed for cleaning when required, it has proven a success.

The pump suction pipe is attached to the other half of the tank in the center of the bottom. The partition in the tank prevents air bubbles from getting into the suction half of the tank, as all the fluid has to pass down under the partition to get there, and this compels nearly all the air bubbles to be liberated in the first half.

This is important, because all the air which goes into the duplex pump collects in the valve chambers and produces irregular motion with pounding.

The weak point in this system now is the operating valves at the presses. A valve is needed which is easily operated, reliable and durable, but we have no such one yet.

With valves as satisfactory as the rest of the system is, there would be no cause for complaint, and if any of your readers know of such a valve, I would be pleased to see some account of it in your columns. —Mr. BELL CRANK, in *American Machinist.*

Air Testing in Tunnel Construction.*

The frequent resort to tunneling in modern engineering construction involves the necessity of furnishing by artificial means a pure, cool, and abundant supply of air for the men engaged in carring on the work. The fumes arising from the use of explosives, the possible presence of inflammable gases, and the exhalations of the workmen, all tend to vitiate the atmosphere of the tunnel headings. These conditions require that effective methods of ventilation shall be employed to insure the safety and health of the workmen. In nearly all underground excavations carbon dioxide, marsh gas, and sometimes hydrogen may be present in greater or less amounts. Sulphuretted hydrogen occures occasionally, and carbon monoxide may be present as the result of the combustion of inflammable gases and from the use of certain explosives. Some of these gases, such as marsh gas and hydrogen are dangerous because of their inflammable and explosive character when mixed with air; some are poisonous to inhale, such as carbon monoxide and sulphuretted hydrogen; and others like carbon dioxide and nitrogen cause asphyxiation. Excepting the combustion of inflammable gases, the exhalations of the workmen form the chief source of carbon dioxide, and ordinarily the ventilation of a tunnel has largely to do with the removal of the vitiated air thus produced.

* A paper presented by Joseph W. Ellms to the Laboratory Section, American Public Health Association, at the New Orleans meeting, December, 1902.

Ventilation is commonly effected by means of exhaust fans, blowers, and compressors; the latter also supplying air for operating drills at the face of the excavation and for other purposes.

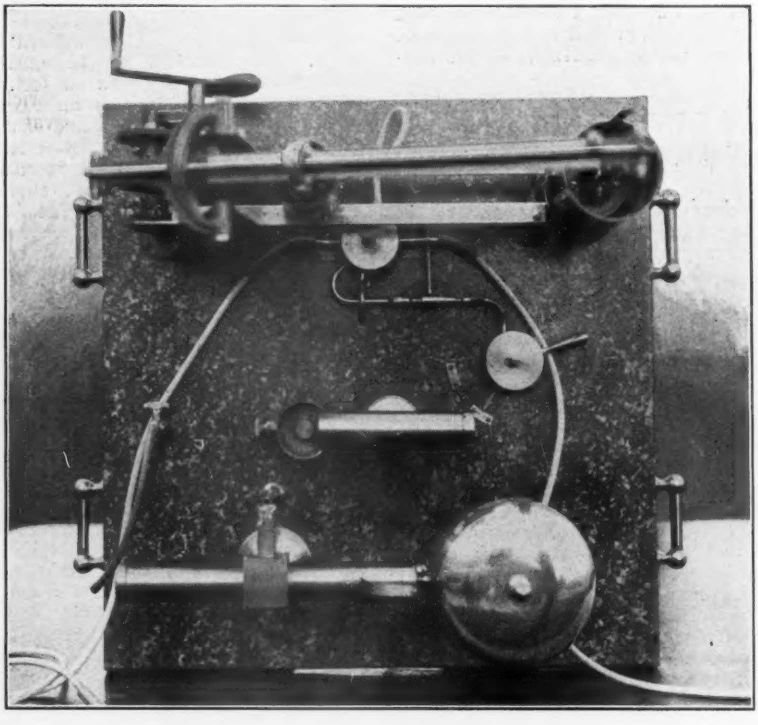
A part of the new system of water works being built for Cincinnati, Ohio, is a tunnel 4 1-5 miles long, which is to convey the water from the reservoirs and filter plant to a distributing pumping station situated at the eastern end of the city. The tunnel lies about 120 feet below the surface of the ground, and has a diameter of 7 feet in the finished brickwork. The diameter of the excavation averages between 9½ and 10 feet. The portion of the tunnel thus far excavated passes through a limestone and shale formation. From the first more or less gas of an inflammable and explosive character was encountered and several explosions occurred. It was therefore decided by Mr. G. Bouscaren, the chief engineer of the Commissioners of Water Works, to test the air of the various headings daily in order to detect inflammable and explosive gases, and also to determine the efficiency of the ventilation of the headings. The writer has had charge of this testing.

It was apparent from the first that the ordinary methods of chemical gas analysis were not well suited to detect gases of an explosive character in the air of the tunnel with the rapidity that was necessary to make the tests of any immediate value. The use of miners' testing lamps of the Davy type by inspectors was considered unsafe and for certain reasons inadvisable. Our attention was called at this time to a mechanical device known as "Shaw's Gas Tester," which seemed to be able to give the necessary information, and which after some investigation was purchased. The machine is capable of detecting quite small quantities of gases of an inflammable character, although it is not able to differentiate between them as a chemical analysis would do. It determines quantitatively the amount of explosive gas present and is sensitive to differences as small as 0.1 to 0.2 per cent. With this device samples of air can be tested very rapidly and it has proven to be well adapted to the case in hand.

The machine consists of two cylinders fitted with air-tight pistons attached by rods to one side of a beam which oscil-

lates on a pivot. The larger of the two cylinders is situated at the extreme end of the beam; the other cylinder is movable and can be placed close to the larger cylinder or next to the pivot on which the beam turns. The beam is moved by means of a winch, which actuates gears connected by a rod to the end of the beam opposite from that to which the piston rod of the larger cylinder is attached. From the lower ends of the cylinders inder and connects with it through a small flap valve. The outer end of the projecting tube is immediately over the top of a Bunsen burner. Near the movable head of the gun is a gong, which is rung whenever an explosion in the gun is of sufficient force to drive out the movable head far enough to hit the gong.

A scale on the side of the beam, to which the piston rods of the cylinders are attached, is so graduated that when



THE SHAW GAS TESTER.*

tubes lead to a two-way valve, which is turned automatically by the movement of the beam. From this valve tubes, so arranged as to mix the air and the inflammable gas pumped respectively through the large and small cylinders, lead to an explosion gun. This gun consists of a long, narrow cylinder having at one end a movable head and at the other a cap provided with a small hole. A small tube projects from the side of this cylthe piston rod of the movable cylinder is set to coincide with any division of the scale, the number corresponding represents the percentage by volume which the displacement produced by the piston of the small cylinder is of that produced by the piston of the large cylinder. As the position of the large cylinder is fixed and the movement of the piston always the same, the air which it pumps is a constant quantity. The piston of the

* We are indebted to the American Public Health Asso., for the illustrations.

movable cylinder, however, moves a longer or shorter distance, depending on its nearness to the large cylinder or to the pivot on which the beam is oscillating. It is evident, therefore, that by changing the position of the small cylinder varying proportions of any inflammable gas may be mixed with a constant volume of air, and may then be forced into the gun to determine whether the mixture is explosive or not.

The method of operating the machine is as follows: A 5-gallon rubber bag is filled with illuminating gas and attached to the tube leading to the movable cylinder. The piston rod of the cylinder is set at about nine on the scale on the beam. The Bunsen burner is lighted in front of the ignition hole of the gun. By turning the winch the beam is made to oscillate. On the up stroke of the beam the air from the room is drawn into the large cylinder, and illuminating gas into the small or movable cylinder. The two-way valve is automatically changed at the end of the up stroke so that the ports open to the tubes leading to the explosion gun. On the down stroke the air from the large cylinder and the illuminating gas from the small cylinder pass into the gun well mixed, and the mixture is gently forced through the gun. A portion of the mixture passes out the side tube of the gun over the top of the flame of the Bunsen burner and is ignited. At the end of the down stroke the ignited gas and the flame of the burner suck back into the main portion of the gun and ignite the mixture in the gun proper. If the mixture is of such proportions as to be explosive an explosion occurs, which drives out the movable head of the gun, causing it to strike the gong.

By gradually decreasing the percentage of illuminating gas added to the air, a mixture can be obtained of such proportions that the force of the explosion is not quite sufficient to cause the bell to be rung. Such a mixture is termed a "standard ringing mixture," and is determined for each set of tests made. It is obvious that, if now in place of the pure air of the room a sample of air containing gas of an inflammable character be pumped through the large cylinder, the gas contained in this air added to the known quantity of illuminating gas being used to form the "standard mixture," will cause a sufficient strong explosion to ring the bell. By further decreasing the percentage of illuminating gas a point is again found where the force of the explosion is insufficient to cause the bell to be rung. If, for example, it was found that a standard mixture of air and illuminating gas, in which the latter formed 8 per cent. of the whole, was barely sufficient to cause the bell to ring, and that when air containing inflammable gas was substituted for the pure air used in the "standard mixture," the force of the explosion was hardly great enough to cause the bell to ring with the addition of only 6 per cent. of illuminating gas, then it would be assumed that the difference between 8 and 6 or 2 was the percentage of inflammable gas present in the sample of air being tested.

The samples of air from the various headings are collected in four-gallon pear-shaped rubber bags, fitted with stopcocks. When empty their sides lie flat together. A small brass air-pump is used to inflate the bags when taking samples of air in the headings. The suction pipe of the pump can be placed at the roof, middle, or bottom of the excavation so as to obtain samples from these different positions. The sample is usually taken near the top of the excavation so as to obtain the inflammable gases, which because of their less specific gravity lie near the roof of the tunnel. These samples are brought to the laboratory daily to be tested for explosive gases and for carbon dioxide.

The testing for carbon dioxide is carried out by the usual method of absorption of the gas in a barium hydrate solution. The air from the sample bags is transferred to calibrated bottles of about one liter capacity. Ten cubic centimeters of a standard solution of barium hydrate are run into the bottle, which is then closed with a rubber stopper. The bottle is then shaken several times to permit the carbon dioxide in the air to be absorbed by the barium hydrate. After standing from five to ten minutes the excess of barium hydrate is titrated with a standard oxalic acid solution. Corrections are applied for temperature and barometric pressure, and the results are stated in parts per hundred for standard conditions of temperature and pressure.

The present method of ventilating the various tunnel headings is by means of air compressors, which supply air for operating drills and for other purposes. The air passes from the com-

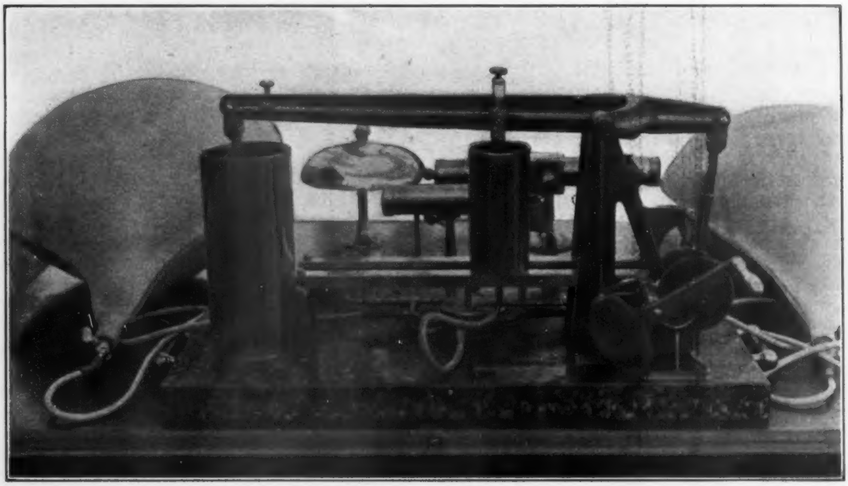
pressors to a receiver and thence is conveyed by a 4-inch pipe to the bottom of the working shafts, where the pipe is reduced to 3 inches. This 3-inch line is laid along the bottom of the tunnel to the face of the excavation. The exhaust from the drills forms the source of the fresh air supply when the latter are in operation. When the drills are not in use the air is permitted to escape at intervals along the line as well as from the end of the pipe.

The explosive gases thus far encountered have generally entered the excavation at points where the water was leaking into the heading in considerable quantity. It may occur in pockets and be liberated in the course of blasting; or it may permeate the rock in places and leak into the excavation because it is under a slight pressure. An approximate analysis was made of the gas bubbling up through the water in one of the headings. It was found to contain 31.0 per cent. of hydrogen, 45.7 per cent. of marsh gas (methane), 2.2 per cent. of carbon dioxide, beside oxygen and nitrogen. The two latter gases were very likely of atmospheric origin, although the oxygen was in excess. There were also some indications of other hydrocarbons being present beside methane. In general the gas is similar in composition to the natural gas found in the Ohio and Indiana fields. It owes its explosive properties to the marsh gas and hydrogen which it contains. The so-called "explosive limits" for mixtures of methane and air and hydrogen and air, as recently determined by Bunte and Eitner, are as follows:

	Lower limit. Per cent.	Upper limit. Per cent.
Marsh gas (methane)	6.1	12.8
Hydrogen	9.4	66.4

It will thus be seen that the mixtures containing between 6.1 per cent. and 12.8 per cent. of marsh gas, and 9.4 per cent. and 66.4 per cent. of hydrogen, will form explosive mixtures with air. Other investigators vary these limits somewhat, and all state that the manner of igniting the mixture affects the results obtained. Below the "lower limit" of explosion mixtures will not explode, and above the "upper limit" no explosions occur, but the mixture burns freely where it lies in immediate contact with a layer of air which will furnish the necessary oxygen to support combustion . The chief danger from the presence of these gases in any quantity lies in their rapid diffusion through the air with the consequent formation of mixtures of such proportions as will explode if accidentally ignited.

It was found that the "lower limit" of explosion of as pure a sample of the gas



GAS TESTER, SHOWING BAG FOR COLLECTING SAMPLES.

as could be obtained from one of the tunnel headings, was about 7.0 per cent. The "upper limit" was not definitely ascertained, but it appeared to be less than 20.0 per cent. These figures refer to tests made with the Shaw gas tester and to conditions such as exist in using this machine. This should be borne in mind if comparisons are made with figures obtained in more exact experiments. Moreover, it must be remembered that the explosive gas occurring in the headings is a mixture of gases and that its composition is probably variable. In the course of the daily testing, samples of air containing as high as 67.0 per cent. of explosive gas has been found. Such samples could not be exploded directly, but burned freely when ignited. In order to obtain an explosive mixture in such cases dilution with air was necessary.

Traces of inflammable gas are not infrequently found. If present at all, however, it usually is in amounts of less than 1.0 per cent. The larger part of the time these gases are absent from the majority of the headings. But since it has been shown that inflammable gases are liable to be encountered at any time, the only safety lies in a continuous testing of the air in order to detect dangerous conditions immediately. About 1,800 tests for explosive gases and 1,700 tests for carbon dioxide have been made during the past year.—*The Engineering Record.*

Pneumatic Tools and their Uses.

THE NEW INDUSTRY AT FRASERBURGH.

The negotiations, which are proceeding in connection with the establishment at Fraserburgh of works for the manufacture of machine tools, now give so much promise of a successful issue that some account may be given of this important branch of engineering industry. Considerable surprise has been expressed at the proposed location of works of this character in the northest of Scotland, but it may be pointed out that in America the chief centres of the machine tool industry are not, as might be supposed, in Pennsylvania and Ohio, in close proximity to the great iron and coal regions of the United States, but in New England, hundreds of miles from what might be imagined to be the more favorably situated places. The Pratt and Whitney Company of Hartford, Connecticut; the Fitchburg Machine Works of Fitchburg, Massachusetts; the Becker-Brainard Milling Machine Company, Hyde Park, Massachusetts, and the Brown & Sharpe Manufacturing Company of Providence, Rhode Island, are a few instances in point. A person familiar with American industrial methods might point to many similar examples in other branches of manufacture. It is to be remembered also that the quantities of material to be handled in the machine tool business are not large proportionately to the amount of labor involved in their manufacture. Pneumatic tools are highly finished pieces of mechanism; at the same time they are comparatively small, and proximity to the raw material is not therefore of such importance as in shipbuilding or foundry work, where great masses of steel and iron have to be dealt with, though, as a matter of fact, the case of Messrs. Harland & Wolff, of Belfast, who have to import from England or Scotland every atom of metal they use, shows that even in shipbuilding juxtaposition to iron and coal is not a supreme factor. Nevertheless, should the consolidated Pneumatic Tool Company erect its British Works at Fraserburgh, the people of the northeast of Scotland will have good reason to congratulate themselves upon the advent of an industry which will be as valuable as it will be unexpected, and there will be the warmest appreciation of the enterprise of Mr. Maconochie, to whom, as is well understood, belongs the credit for pushing forward this scheme so full of possibilities for this part of the country.

The use of compressed air for the operation of tools is one of the more recent developments of engineering, and it is in America that it has made most progress. The Westinghouse air brake, with which we are familiar on our railways, may be said to have been the first practical application of pneumatic pressure. Now a complete compressed air installation is part of the equipment of many foundries and workshops, consisting of the central air compressor, the pipes and tubing, which convey the air to the various departments, and the actual pneumatic tools. In granite work, in which Aberdeen is particularly interested, pneumatic tools have become an essential feature of every well-furnished establishment, and their ap-

plication to dressing, chiselling and carving has opened up new possibilities for this local industry. The earliest compressors were simply pumps such as are used in locomotives in connection with the Westinghouse and automatic brakes. They were of low efficiency, and they have now been replaced for stationary purposes by special air compressors, designed to meet the necessities of different establishments. Pneumatic appliances may be roughly divided into small portable tools such as hammers and drills and larger pieces of mechanism like hoists and cranes, which necessitate a greater expenditure of power. The work done by pneumatic tools is generally such as has previously been done by hand, and except in the case of hoists, it does not appear that compressed air can vie with electricity as a motive power for heavier machinery, such as planing and milling machines. But to work such as hammering, electricity cannot be applied. A current of either steam, water or air is necessary, and of these three air has the deciding advantages, that it can be easily conveyed in tubing, and that the exhaust gives no trouble. The experience of American workshops has shown that the increase of output of a workman and his pneumatic tool over that of a workman using the old hand tools is so much greater than the increased cost due to the added expense of maintaining and operating the pneumatic plant that the work is done at far less cost per unit. The saving in boiler rivetting, for instance, when done by pneumatic tools, is 66 per cent. in cost, and 50 per cent. in time. In other kinds of work it is even greater.

Of the numerous pneumatic tools now in use a few may be mentioned. The simplest perhaps is the hammer. It has a handle like that of a saw, and it is connected by a length of flexible rubber tubing with the fixed air mains. The head of the hammer is the piston, which is operated directly by the air current, and which in some designs strikes from 10.000 to 15,000 blows per minute. These high-speed hammers are used for chipping and caulking. For rivetting work, in which a heavier blow, is required, valve hammers delivering from 1500 to 2000 blows per minute are employed. In boiler-making and in the erection of bridges and steel work, machines of this kind are particularly applicable, and these pneumatic hammers have even been used by divers working on a sunken wreck. In the same category may be included the pneumatic sand rammers, which, according to an interesting article on compressed air and its uses in the current issue of "Cassier's Magazine," enter largely into foundry practice in America. These rammers vary from small hand ones to large pieces of apparatus swung from a crane, and their application has not been confined to foundries, but has been extended to the ramming of concrete in building work. Of almost as much importance as the pneumatic hammer is the pneumatic drill. Instead of taking a heavy piece of metal to a stationary drilling machine, the newer method is to take the pneumatic drill to the piece of work to be done. The rubber tubing can be bent in any direction, and a pneumatic drill can be set to work in out-of-the-way corners which it would be difficult to reach with stationary drills on hand ratchets. By the use of such drills, holes may be put in at a rate many times that possible by hand. Rock drills driven by compressed air are used extensively in mining and tunnelling. Other purposes for which pneumatic tools are now commonly employed are reaming and expanding boiler tubes, grinding steam joints and driving a special tool for the removal of flues from old boilers, an operation that was formerly very tedious and costly. Many pneumatic tools, like those employed in the granite trade, are provided with taper sockets, so that a variety of tools may be used, and to quote the writer in "Cassier's," "once installed, they constantly suggest new uses and prove their value from the start."

Pneumatic sand rammers for foundries have been mentioned. Other foundry devices are pneumatic sand sifters, sand blast tumble-barrels and pneumatic brushes for cleaning castings, and air blasts, something like a powerful water-hose, for cleaning the cores of castings. The buildings at the Chicago World's Fair were painted by pneumatic machines, which blow the paint on in the form of a spray. Compressed air has also been applied to the burning off of old paint; to the operation of small presses, where the work to be done is not sufficient to require great hydraulic presses; to cleaning machines for use in railway carriages, and to a variety of other purposes. Pneumatic hoists and pneumatic overhead trolleys, for conveying materials from one part

of a work-shop to another, are in use. They are stated to have this advantage over electrical apparatus of the same kind that dust and grit cannot hurt them beyond increasing the frictional wear. It is evident that the field for pneumatic tools is a large one, and that the possible uses for these convenient and economical appliances have not by any means been exhausted. A notable instance of compressed air equipment is at the Baldwin Locomotive Works at Philadelphia, where there is a generating plant of ten compressors, and where over 100 pneumatic drills are employed, in addition to pneumatic rivetters, hammers, moulding machines, and so on. The Passaic Rolling Mills in New Jersey are similarly equipped, having 40 pneumatic hoists alone. Hitherto the demands of engineers on this side of the Atlantic have been mainly met by imported apparatus. Like other great American concerns, such as the Westinghouse and the Thomson-Houston electrical firms, the Pneumatic Tool Company is now going to commence manufacturing operations in this country, and, unless some unforeseen difficulty occurs, Fraserburgh will be the scene of its new enterprise.—*Aberdeen Press.*

Sinking a Shaft by Compressed Air.*

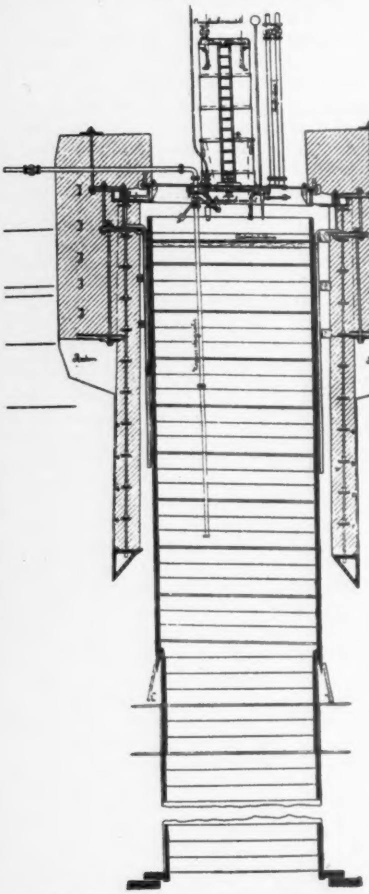
When the necessity arose of sinking a second shaft at the Recklinghausen I. Colliery last year, it was hoped, from the experience gained in adjacent properties, that no great difficulty would be encountered in passing through the known 45 to 50 feet of quicksand by means of a sinking shaft and wall. Work was therefore commenced with an iron sinking shoe to form a shaft measuring 20 ft. diameter when lined, but after traversing the first 30 ft. of quicksand—which, moreover, was very wet, probably through infiltration from the adjoining river Emscher—a number of fragments of rock impeded the advance of the shoe and tilted the sinking shaft out of the vertical. At the same time serious subsidences were discovered round the shaft, and as these extended close up to the air culvert of the neighboring shaft, the work was suspended and the sinking of a 16 ft. iron shaft within the lined sinking shaft was decided upon. While the iron shaft was being cast, eight guide rails were fastened in position inside the bricked shaft, to guide the former, leaving a play of just over an inch between the rails and the outer wall of the iron shaft; and a 4 in. flange was arranged on the inside of the sinking shoe, to facilitate the fitting of the lower tubbings to the sinking shaft.

The iron shaft was first mounted on a firm stage above the water level, and suspended from the aforesaid flange by twenty rods. By the time the seven rings of tubbing had been assembled, the cutting edge of the shoe had reached the level of the quicksand in the lined shaft; but as it was found impossible to get the shaft down beyond about 3 ft. further, eight 60-ton hydraulic presses were mounted between the upper tubbing and the pressure ring, and the effect of these presses was assisted by excavating at the shaft floor. Notwithstanding these measures, the influx of quicksand could not be kept back, nor could the shaft be forced lower than about 45 ft.; whilst the increasing subsidences round about the periphery necessitated continual filling up and levelling at the surface. At the same time the air culvert sustained some damage and the sinking shaft began to tilt owing to the fact that part of the cutting edge of the shoe was already resting on the underlying marl.

To overcome these difficulties it was resolved to resort to the use of compressed air, in preference to the alternative congelation process or the introduction of a smaller sinking shaft, the reason for this choice being that the adoption of the last method would too greatly reduce the diameter of the shaft, the congelation process would be too costly for the small distance to be traversed, and it was highly problematical whether the boreholes could be sunk perpendicularly, in view of the presence of stony fragments in the sand; finally, because the colliery was already provided with two powerful air compressors. The pressure ring was therefore surmounted by an air lock, consisting of an iron cover 0·4 in. thick and an old boiler attached to the cover by rivets, the dimensions of the boiler being 64 in. in diameter and 14¾ ft. high. Assuming the pressure required to be 2 atmospheres, the surface of this lock would have to

*Bergassessor Lüthgen. *Glückauf.*

stand a total pressure of nearly 400 tons, only a portion of which would be taken up by the sinking screws. The cover having been packed close, it was therefore topped with a number of double-T girders set close together, and these in turn were loaded with tubbings, curbs, &c., to a total



TUBE FOR SHAFT SINKING IN SOFT GROUND.

weight of about 350 tons. The cover was fastened to the pressure ring by means of 120 set screws, the joint being packed with nearly ½ in. of sheet lead, and ⅞ in. screw bolts were inserted in the holes previously serving for the reception of the anchor rods for the iron shaft. Flaps of 0·4 in. iron plate covered with 2 in. boards, and arranged to open downwards, were provided in the cover and bottom of the boiler, the joints being closed by leathern strips resting against wooden frames. These flaps weighed nearly 2 cwt. and were fitted with counterpoises to facilitate closing, and the upper halves of each were provided with split bushes of red brass for the passage of the skip cable. Five orifices were drilled through the cover, two of them for the passage of the compressed air pipes (3¼ in. diameter), one of similar size for the water discharge pipe, one for an electric signalling wire, and the fifth for a ⅝-in. gas-pipe to which were attached the two pressure gauges; the first three pipes were fitted with valves above bank, in order that they might be opened or closed at any time.

In order to produce the excess pressure in the airlock, a 3½-in. iron pipe was employed to connect the interior of the lock with the space below the shaft cover, the valve of which pipe could be controlled both from within the lock and from the working stage about 3 ft. below the shaft cover. Ordinary safety lamps were used for lighting, but were turned down lower than usual owing to the elongating effect of compressed air on the flame cone. To enable the sinking shaft to stand the high internal pressure, it was surrounded with a strong outer wall of masonry (about 3 ft. thick) down as far as the water level, where it rested on a concrete foundation. On testing the arrangement, it was found that an excess pressure of as little as 0·6 atmosphere caused the water to recede, the level sinking nearly 18 in. in the first half hour, without the valve in the discharge pipe being opened. At the same time the wall began to exude water, and to show a few cracks on one side, as well as sundry leaks around the shaft. Consequently, it was decided to strengthen the wall by a further thickness of three to four bricks and insert channel-iron rings, the weaker side being made four bricks thicker, and the rest three bricks; and in addition the wall was raised about 6 ft. above the pressure ring and fastened with anchor ties.

At the time of commencing work the shaft had sifted up with over 10 ft. of quicksand, surmounted by about 22 ft.

of water. On admitting air under a pressure of 0·6 atmosphere, the water was expelled through the discharge pipe, and at the end of eight hours the shaft was sufficiently drained for work to be commenced on the floor. On admitting the shift of eight men, who entered by means of two wooden ladders, the rope hole in the upper flap was closed by a wooden plug; and pressure was then turned on in the lock by gradually opening the air-pipe valve from the shaft, so that, the pressure becoming equalized, the lower flap could be opened ana the working stage easily reached, whence access to the shaft floor could be gained by several flap doors. Owing to the comparatively rapid retirement of the water under the influence of the compressed air, the wet sand soon became dry enough to dig out into the skips, which were first raised into the air lock, and after closing the lower flaps and the equalizing valve, could be drawn through the upper flaps to bank, emptied, and returned in the reverse way. In twenty-four hours the sand was all excavated down to the level of the iron shoe, fifty-five skip loads, equal to thirty tub-loads, being raised in the six-hours shift. The iron shoe was found to be resting on the marl in one place, but, even after excavating under it for about 2 ft., the shaft could not be forced down any lower, and therefore a channel-iron ring, 18 ft. in outside diameter, was set in position at a depth of 2 ft. below the level of the marl, the intervening space between this ring and the shoe being then filled with a lining of 2 in. planks. After backing this wall tightly with hay, the air pressure was reduced and water run into the shaft through a main, the sinking being thereafter continued by ordinary means.

Altogether the compressed-air method was in use for about sixty hours The chief inconveniences experienced were from the considerably-increased temperature, and the noise of the incoming and outflowing air which made hearing difficult at the shaft floor. Although a pressure of as much as 1½ atmospheres were employed some of the time, none of the men were unfavorably affected, except two who had probably taken more alcoholic stimulants that was advisable; in fact, one of the officials remained for eleven hours in succession, of his own accord, at the bottom. On issuing from the shaft most of the men experienced a singing in the ears, accompanied by slight headache, and in two cases with bleeding at the nose. It is therefore considered advisable, in future cases, to shorten the shifts, lengthen the intervals of rest, and employ a larger staff of men.

After removing the air lock and draining the shaft, the hay stopping proved effectual in keeping back the quicksand, only a little water leaking through; so the shaft was deepened about 3 ft. through the marl, and a ring of tubbing was suspended from the inner flange by means of strong iron hooks, the deviation from the vertical being compensated by inserting boards of unequal thickness in the horizontal joint. Owing to the presence of the sinking shoe, it was impossible to lower the closing ring in one piece, and the latter had, therefore, to be made in two unequal segments, the smaller being fitted with a straight vertical flange. On deepening the shaft, to allow of the insertion of a second ring of tubbing, a slight subsidence of the sinking shaft occurred after three segments had been put in position, and—probably by crushing one of the boards behind the sinking shoe—opened a path for the quicksand to flow into the shaft again. To dam this back below the first ring of tubbing, oaken planks, 1½ in. thick, 40 in. long, and about 6 in. wide, were driven into the marl, the width being a little greater on the sides next the shaft wall. One end of these boards was fastened below the ring of tubbing, the other finding sufficient support against the marl. At the part where the ring rested on the three segments of the second ring, the boards were replaced by iron wedges, but this work was not begun until after the space between the sinking cylinder and the wall had been filled with concrete, to prevent the further descent of the sinking shaft, and to form a solid layer behind the shoe. The pressure of the column of water was reduced by drilling a hole through a segment in the lower part of the sinking shaft, which done, the inflowing sand, &c., was cleared out and the second ring of tubbing completed. After driving a second curb of planks below this ring, the space at the back was filled up with concrete. From this point onward to the

more solid marl, at a depth of 88 ft., the sinking was continued in the ordinary manner, with provisional timbering, and then a double wedge curb was put in, no further difficulties being thereafter encountered in erecting the additional tubbings.—*Colliery Guardian*, London.

Some Records of Sand Pounding with Pneumatic Rammers.

With the exception of a few inches of sand next to the pattern, by far the greater volume of sand necessary for a large mold may be rammed up by anyone who has sufficient muscle to drive this together, so that it will withstand the pressure of the iron. In green sand molding that part of the ramming requiring skill and delicate touch is done in the six inches of sand immediately surrounding the pattern. When we enter the dry-sand branch of the trade the problem of ramming a mold properly disappears nearly altogether, because with the right kind of a sand mixture and proper drying of the mold it is almost impossible to lose a casting, no matter how careless the ramming has been done, so long as the mold is of sufficient density. That practically no skill is required in ramming up molds which are dried is shown by the fact that when molders, who have never worked on any other class of work, attempt to do green sand molding, they all without exception prove a failure at the start and have to learn a part of the trade over again.

RAMMING UP A COPE WITH PNEUMATIC RAMMERS.

The ramming of the larger class of

molds by pneumatic machines is growing in favor and there is no reason why this method should not steadily gain ground. In the first place, with the exception of green sand molding, there is nothing mechanical about pounding a lot of sand together, proof of which is given in the ramming up of many kinds of molds, from those for water and gas pipes to molds for cylinders, by common laborers. If pneumatic rammers will take away much of the hard work done in connection with ramming up molds, the molder ought to be thankful, for even under the best of circumstances he will do enough of a laborer's work. Just how effective a power rammer will be in green sand molding will, of course, depend upon the skill of the operator, yet, as stated before, there is nothing to prevent the greater part of the mold from being rammed up by this method. Certainly after the first course of sand has been rammed in a large cope, the balance may be pounded down good and hard, and if pneumatic power will do this in less time than it can be accomplished by hand, there can be but little use in offering objections.

The Philadelphia Pneumatic Tool Co., of Philadelphia, have for a long time devoted special attention to pneumatic tools for ramming sand, claiming the honor of having made the first hand power rammer and at the present being the only firm manufacturing a power foundry rammer. They say that founders in general are beginning to realize the value of the pneumatic rammer and that the molders, once they learn that these tools remove most of their hardest work, take kindly to their use. To show the advantages of these rammers the Philadelphia Pneumatic Tool Co. quote some of their performances, from which it is learned that at the plant of the Dodge Mfg. Co., Mishawaka, Ind., a split bevel gear of 5 ft. diamater, was rammed up complete by one man with a pneumatic rammer in six hours against 14 hours by the old method. The Buckeye Malleable Iron & Coupler Co., of Columbus, Ohio, have with a pneumatic rammer obtained 150 drawbars in 10 hours against 48 by hand ramming. At the foundry of the Atlas Engine Works, Indianapolis, Ind., copes and drags, 4 ft. 6 inches square and 8 inches deep, were rammed up in 5½ minutes each, while in the shop of the George H. Smith Steel Casting Co., Milwaukee, Wis., a cope, 8 feet square and 12 inches deep, was rammed up in 55 minutes. Other examples of the efficiency of the pneumatic rammer are mentioned by the Philadelphia Pneumatic Tool Co., the above being a fair average of these performances.—*The Foundry.*

A Novel Jib Crane.

In the new foundry of the Gruson Iron Works, at Eddystone, Pa., David Townsend, who is general manager of the plant and was the engineer in charge of its construction, has devised a series of jib cranes which prove interesting features. The cranes are built up of channels, angles and plates, and are so constructed that they revolve completely around an ordinary I-beam column, to which their bearings are fastened. The cranes are mounted on steel balls, so that even when loaded to their full capacity they can be revolved by hand with ease.

Each crane is of 3,000 pounds capacity, being provided with a Pedrick & Ayer pneumatic hoist, supported by trunnions resting on grooves in the top of the frame of a four-wheel trolley, which is moved by hand.

The general construction is shown in Fig. 1. The trolley, it will be observed, travels on the steel channels, which provide the horizontal beam or jib. These are 6-inch channels, 15 feet 7 inches long, and weigh 13 pounds per foot. They are located 20 inches apart, being connected at the forward end by two pieces of angle iron and riveted to a ¼-inch plate forming part of the frame or box surrounding the column. The supports to the jib are also of 6-inch channels. In addition to the end fastening, the channels forming the support and jib are connected by angle iron braces, as shown in Fig. 1.

The upright frame or box, which serves as a mast, is built of 2½x2½x¼ inch angles and ¼-inch plates. The top of this frame is 15 feet 9 inches above the floor. The bottom of it is elevated 18½ inches. The sides are 33½ inches wide. This frame is bolted around two halved cast iron plates, each having a circular opening in the center sufficiently large to revolve around the column. One of these plates is located at the bottom of the frame and the other is within 3 feet 7 inches of the top, or directly behind the jib. At

FIG I.—SHOWING GENERAL APPEARANCE OF CRANE.

suitable points on the column the bearings are fastened. These consist of divided cast iron circular plates, Fig. 3, bolted to the column. They are provided bolted to the column thus bear the weight of the crane and its load, and furnish a circular track, allowing the crane to perform a complete circle about the col-

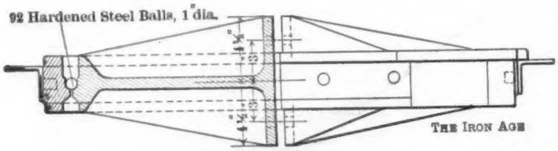


FIG. 2—SECTION OF UPPER BALL BEARING.

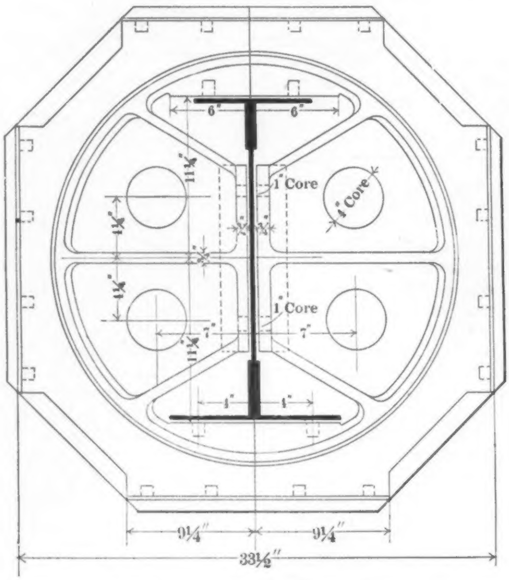


FIG. 3—PLAN OF BEARINGS.

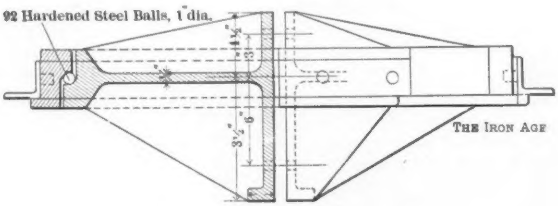


FIG. 4—SECTION OF LOWER BALL BEARINGS.

with grooves, Figs. 3 and 4, as are also the plates joined to the frame, making a runway for the steel balls. The segments umn. In attaching the crane to the column 1-inch holes are drilled through the latter in the positions to be occupied by

the bearings. The segments are provided with 1-inch cores to correspond, and they are bolted to the column.

The crane being completely assembled, with the exception of the rear half of each of the grooved plates, the angle iron back of the frame is then placed in position, the balls being properly placed in their grooves. The assembling is then completed around the column.

As will be noted by the illustration, Fig. 1, the cranes can be used very advantageously in swinging materials from the bays to the central span of the building, and *vice versa*. One of them is conveniently located on a column near the core room, which is located in one of the bays. Heavy cores can be swung by this crane from the core room to the trucks of the core ovens without further handling.—*Iron Age*.

Oiling System for Power Plants.*

A good oiling system, that is, one that can be depended upon at all times—in fact, be more reliable than the ordinary oil cups and filters would be, and is a valuable addition to any power plant; the reason they are not in more constant use is their seeming unreliability as well as first cost.

The first thing to be considered in connection with a good oiling system is drainage pipes and tank. All oil should be trapped in the neatest manner possible—that is, at the closest point at which it leaves the bearing. I have found for side-crank engines where a circular shield is used for same, a complete housing between shield and crosshead, covering connecting rod, is a great saver of oil. It seems to look odd at first, but when considered in connection with engines that are completely housed up the looks improve somewhat.

It is also absolutely necessary to make tight joints at all places where oil is led off from engine bed, as any amount of oil, however small, that leaks by and has to be wiped up is clearly wasted. This is especially true of joints of shields on both sides of main bearing, which usually catches the oil from main bearing, crank and eccentrics. After considerable experience with different methods and ways of packing same, which is usually a difficult task, as they are hard to get at, I have found this a very good as well as inexpensive method.

Wipe thoroughly clean of oil and grease, then at point where shield and bed plate meet put on a coat of shellac by tieing a small brush or, what is just as good, a piece of cloth on end of stick, by which you will be able to get under and around crank disk; when this is partially set take ordinary friction tape and lap same over joint, over which add several coats of shellac. This is practically indestructible and will remain until joint is broken by removing shield.

I have seen quite a number of oiling systems, both of the gravity and air pressure or force pump styles, most of them were more or less unsatisfactory, the one kind due to the high pressures that are maintained, in which case it is necessary to flood the engine with oil, for if throttling down the sight feeds is tried it will soon be found that any small particles of foreign matter or even the viscosity of the oil itself will cause them to stop feeding, thereby causing constant attention.

The other, or gravity style, has some advantages over the pressure style, as the tank can be placed at a slight elevation so that sight feeds can be set nearer full opening, but even in this case the diffierence in pressure, due to the various heights of oil on tank, would be considerable, causing oil to drop very much slower when tank was nearly empty than it would when full. This will be more readily seen when it is noted that an ordinary oil cup two or three inches high feeds very much the faster when it is full.

The secret, then, of a successful oiling system lies in keeping the oil which supplies the sight feeds at a constant level regardless of whether the supply tank is full or nearly empty.

Now it will be seen that when tank is filled the oil will rise in the stand pipe a corresponding height, valve at top of tank now being closed; the oil in stand pipe will readily feed down to level of sight feeds or to a point where air will be let into bottom of tank, thereby causing oil to run out, and this point will be the constant oil level, which in my opinion, should not be more than six inches above the level of sight feed oilers.

*Paper read by P. E. Moock before the Ohio Society Electrical, Mechanical and Steam Engineers, Warren, Ohio, Feb. 14, 1903.

Referring again to the ordinary oil cup, it will be seen that not much fall is needed. The sight feeds should all be on the same level and once properly set need never be shut off, as a valve is placed in branch to each engine, so that all that is necessary when starting or stopping an engine is to open or shut this valve. I would recommend that oil cups be left on the important bearings, such as main bearing, crank and eccentrics. As before stated, they should all be on the same level. It will be seen that a common level will be maintained in all the cups at all times, no matter whether feed is on full or shut entirely off. Cups can be connected by bending one-fourth inch tubing as shown, drilling holes in bottom of cups and soldering same, thus connecting them in series. The supply pipe coming to center of bank cups and feeding both ways. At other places, such as outer bearings, crossheads and guides, sight feeds could be used, both methods being given. This may be arranged as individually desired. Each will work equally well, conditions being right, the cup arrangements having the advantage that if, from any cause, the oil supply from main tank was cut off the cups, being nearly full, would act as a reservoir, and as they would keep on feeding, thereby lowering the oil level, which would be quickly noticed by the attendent and the supply replenished by hand with oil can until the trouble was remedied. While the danger of this happening is very remote, yet it should be provided for, and in the case of sight feeds being used throughout a small auxilliary tank could be placed between shut-off valve and feeders. This need not be left on, it being necessary, of course, to have it fitted up so that it can be quickly applied. Main supply tank should be tapped several inches from bottom to allow for sediment, and also have a good screen over drain and supply pipes, thereby keeping out all foreign matter as well as helping to purify the oil.

The matter of oil filtration, however, is not of so great importance as some seem to think, for if an engine bearing is in proper shape and well taken care of there is no nicer, cleaner, smoother place to be found, and in passing through such a bearing oil will not be harmed. The way to get it nearest to its original color is to let it stand in a closed vessel for several weeks. Indeed, this is an ideal way of filtering oil and all that is necessary is a small oil house in which can be stored several hundred gallons of oil. I would recommend in this connection a small filter, principally for removing entrained water from the oil, and as the best results are obtained by slow filtration, this part of the system should be so arranged that the oil would be passing through the filter regularly drop by drop as it leaves the engine, drawing off the water at bottom and adding sufficient new oil to maintain a constant level.

I have not given near all details, as that would be tiresome, and, at any rate, there are a number of different ways of doing the same thing. However, I have given sufficient outline so that any one interested will have no trouble in working out same to their entire satisfaction.

This system is what I would term a home-grown one, such as any engineer during leisure hours could install, and it is inexpensive. The cost, other than labor and oil house, for a thousand horse power plant need not exceed sixty dollars, and in a plant of this size will save its cost in oil in six months.

Compressed Air Crane Hose Support.

We show herewith an extremely ingenious method of supporting the hose for supplying compressed air to traveling cranes. The method which has been used more than any other for this purpose consists of stringing the hose by ring hangers on a taut wire, the hose hanging in loops when the crane is at one end of its run-way and being straightened out under the opposite condition. This method involves the use of a hose of a length equal to the shop, and the fact that it lies in loops most of the time, while these loops always bend the hose at the same places, is undoubtedly detrimental to the life of the hose.

A hose of half the length of the shop, with a weighted carrying sheave, has been used in some cases, but the extent of rise and fall of the counterweight makes this plan undesirable. The present plan uses a hose of but half the length of the shop in combination with a carrying sheave, and by an extremely ingenious arrangement of sash cord the hose is kept in position

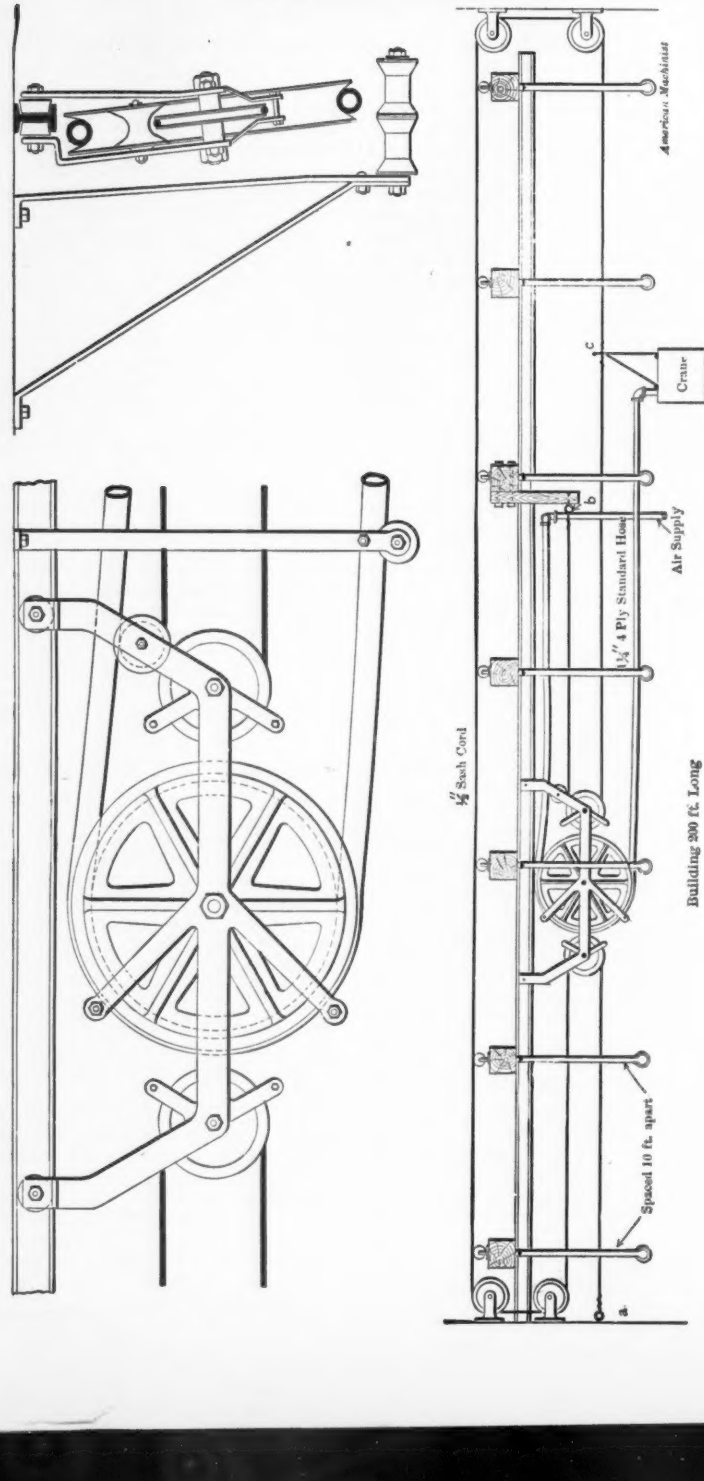


FIG. I—COMPRESSED AIR CRANE HOSE SUPPORT.

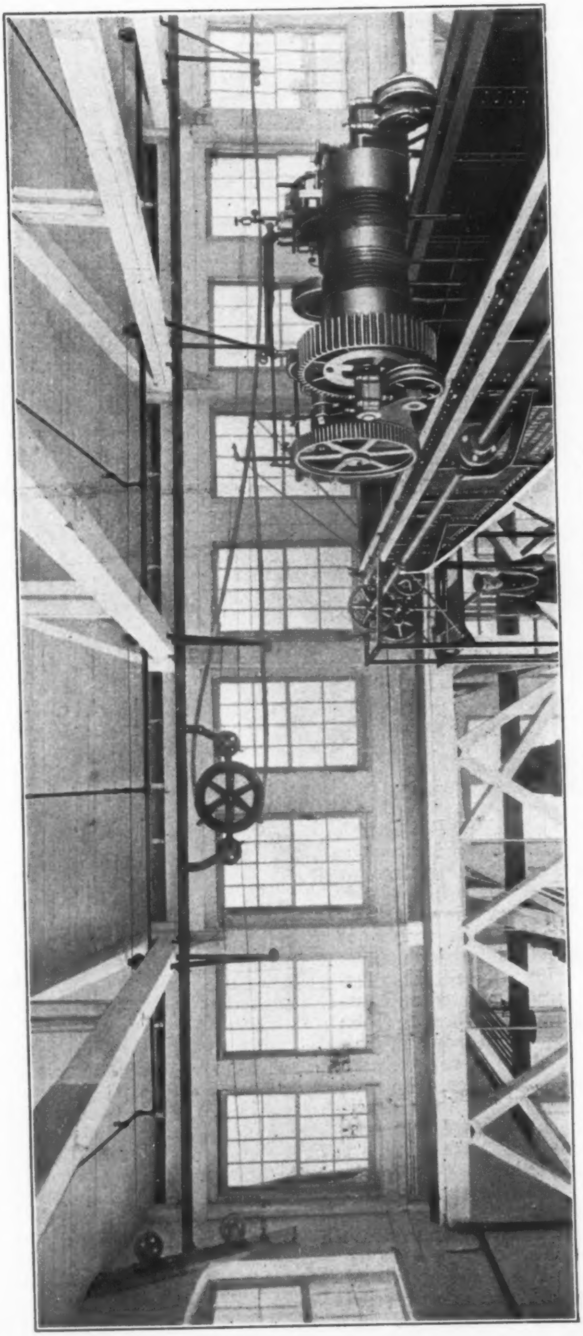


FIG. 2—COMPRESSED AIR CRANE HOSE SUPPORT.

without the use of a rising and falling weight.

Fig. 1 shows the arrangement diagrammatically, the crane being indicated only. The ends of the cord are secured at *a* and *b*, and the cord is again attached to the crane at *c*. During the movement of the crane toward the left it is clear that the action of the cord will be to carry the sheave in the same direction at one-half the speed of the crane, and so take up the slack of the hose. The upper views show the arrangement of the sheave in greater detail. Permanent changes in the length of the rope due to use are taken up from time to time by re-tying the rope at the crane end, and, except in extra long runways, we doubt if temporary changes in length, due to changes in the moisture in the air, would cause any annoyance. If found to be so, they could be easily provided for by carrying the end *a* over a sheave and hanging a weight, slightly greater than the tension on the rope, to it. This weight would not, of course, rise and fall with the movements of the crane, but would gradually settle with the stretching of the rope.

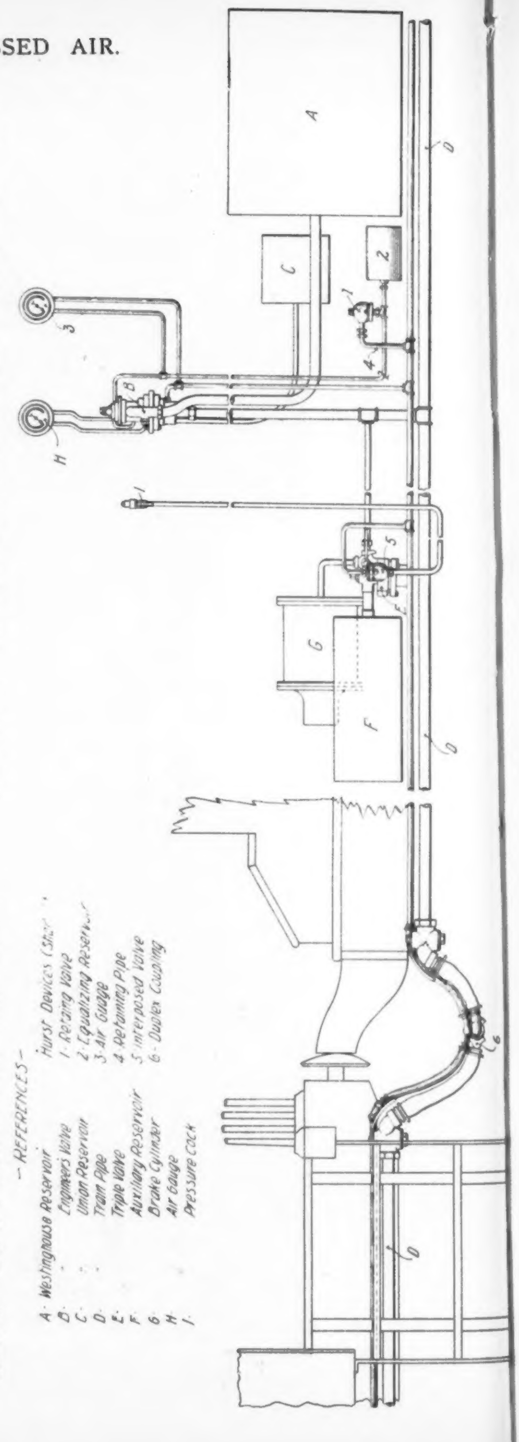
We must say we fail to see the need of the portion of sash cord between *b* and *c*. The hose itself would seem to be able to do the work of this part of the sash cord.

Fig. 2 is from a photograph, and shows the arrangement as it appears in use.—*American Machinist.*

Hurst Air-Brake Improvement.

In the air-brake room of the Rio Grande Western shops at Salt Lake City, and on the engines of that road some interesting experiments and road trials have lately been made with the Hurst improvement for automatic air brakes, the results of which evidenced in a satisfactory manner the value and practicability of the apparatus. This device was invented and patented in 1895 and 1896, by the late John M. Hurst, master mechanic of the Salt Lake and Ogden road, and previously an engineer on several Utah lines, who died before the improvement was fully developed. The patents then passed into possession of others and after the appliance was further perfected, a corporation known as the Hurst Air-Brake Co., was organized for exploiting it.

The Hurst improvement is an automatic retainer, designed for the purpose of holding the brakes set while recharging, and the trials above mentioned were carried



on especially for the purpose of proving the efficiency of the attachment on steep grades and under the conditions of a mountain road.

The apparatus is intended to avoid the present waste of air, to make quicker and smoother stops possible on rapidly moving trains, to keep auxiliaries always charged and ready for emergencies, to avoid the flattening of wheels by placing control of the brakes entirely in the hands of the engineer, and finally effecting an economy in the consumption of air. It is especially adapted to rapidly moving trains which have to make frequent stops; and to long and heavy freight trains on extreme grades.

The accompanying illustration shows the regular Westinghouse air-brake apparatus, and the Hurst improvement (parts shaded) in which the parts of the former are designated by letters A, B, C, etc., and the latter by the numbers 1, 2, 3, etc., the drawing represents the arrangement of the apparatus on the engine, tender and first car. The air from the engineer's brake valve reservoir (C) controls the retaining valve on the engine (No. 1) and the air from the train-pipe (D) controls the interposed valve on the car (No. 5). The gauge (No. 3) shows the pressure retained in the brake cylinder and retaining valves. The retaining reservoir (No. 2) is made about one-half the size, or less, than the engineer's brake-valve reservoir, thereby retaining 2 to 2½ lbs. for every pound exhausted from the brake-valve reservoir. The pressure goes into retaining valve (No. 1) which is divided by a diaphram having a stem, in the center which seats on an exhaust port on the opposite end of the valve. On the other end of the valve the air comes from the train-pipe and being unable to get out flows back through the retaining pipe (No. 4), passing to the interposed valves, closing them the same as the retaining valve.

The retaining valve allows the engineer to make a gradual release of the air from the brake cylinders in much the same way that a gradual application of the air is made in the first place—an interesting feature of the improvement. It is believed that this will do away to a large extent with the parting of trains and insure smooth handling of trains on a down grade. The retaining valve also lets the excessive pressure out of a brake cylinder having a short travel, making it correspond with a 7 or 8-in. piston travel.—*Railway and Engineering Review.*

Test of New Automatic Gun.

H. A. Rademacher and Franklin J. Jewett, of Brooklyn, and William C. Stone, of Utica, N. Y., are arranging for the second test of a new automatic gun, the patents for which are pending. The new gun, which is now being perfected, will be operated by compressed air. A departure in its scheme is that the bullet will not be closed in a shell as in other automatic guns. It is the joint invention of Mr. Stone, who is a civil engineer, and Mr. Rodemacher, a Brooklyn chemist. Mr. Jewett is simply interested in the new arm.

The gun is of automatic type. Heretofore a portion of gas resulting from the explosion of cartridges has been used as a means for opening the mechanism of such guns. Experience has shown this to be objectionable, and in the gun which is now being perfected the recoil of the barrel is utilized to compress a certain amount of air, which is used as the motive power of operation.

The gun complete weighs about 280 pounds, and has no single piece weighing over 20 pounds. Its most important feature is the character of the ammunition used. Heretofore all the fixed ammunition consisted of a metallic shell, containing explosive material and primer, in the outer end of which the bullet has been concealed. In this new cartridge the metallic shell or casing is entirely disposed of. The new explosive is a secret compound of the nitro-gelatine type, a sufficient quantity of which is secured to the base of the bullet. This material is nearly as hard as the lead of the bullet. It is water and concussion proof, and can only be exploded by the use of a special primer, which has been especially designed for this purpose. The material is inflammable and can be ignited with an ordinary alcohol lamp. The total amount of explosive used for the cartridge is small in a 45-calibre bullet, being only one-quarter of an inch thick. When exploded it leaves a very small residue in the barrel of the gun.

It is intended by the owners of the gun

to locate their plant in Utica and manufacture both the gun and ammunition in that city. An effort will be made to organize a stock company, and with any support whatever the venture should attain success.—*Utica Press.*

Mine Fires.

An underground conflagration is one of the most dreaded catastrophies with which mines are visited. Outside, on the surface, a fire can generally be attacked from a number of vantage points by the firemen; but in the cramped and narrow mine workings it is usually most difficult for a man to work his way through the smoke and deadly gases given off by the fire to a point from which to attack the flames. Prompt, energetic action may extinguish the blaze or confine it to a small section, but when once a mine fire gains headway it may be necessary to flood the workings to put it out. In many instances destruction of valuable property nas been averted and lives have been saved by men provided with the Vajen-Bader head protector. The wearer of this helmet was thereby enabled to work in an atmosphere in which a man ordinarily could not live, and successfully fight fire, restore doors and brattice after an explosion, and by prompt removal to fresh, pure air, save lives that would have been lost in the deadly mine gases, Fig. 1.

This helmet is made in two sizes, the larger of which supplies a man with fresh air for several hours; it encloses the head as shown in Fig. 2. It is about the same weight as that of a thick overcoat and is supported in a similar manner when worn; it rests on the shoulders and is held firmly in place by two straps passing under the arms. It is constructed of a double thickness of leather, the outer layer being horse hide chemically treated to render it fireproof and waterproof. At the rear is shown an air cylinder from which leads a tube ending in front of the nostrils. Fresh air is supplied to the wearer, at about the natural pressure, from the reservoir, which can easily be recharged in a short time, by the special air pump included in the outfit.

After the helmet has been adjusted to the body, the wearer turns on the air by the valve shown on the right side of the gauge, which indicates the amount of air in the reservoir. The cylinder on the larger size protector carries air at 150 pounds pressure when full. The fresh air being constantly forced into the helmet, creates an outward pressure, and the foul air escapes through the neck gear and around the bottom, which is lined with absorbent lamb's wool. The two lookouts are constructed of double plates of clear mica with revolving cleaners, and are protected by four cross-wires. The side or ear pieces have special sounding diaphragms so as to render the hearing dis-

FIG. 1—RESCUE WORK WITH VAJEN-BADER HEAD PROTECTOR.

tinct. The whistle attached in front is used for a call and is a convenient means of signaling. The helmet furnishes full protection to the head from falling debris or on striking top rock or timber, as it is padded on top and reinforced with four ribs.

The setscrew between the gauge and the valve is regulated by a screwdriver and should be tested as to adjustment, from time to time, to see that the air is delivered to the helmet at the right speed. When the device is needed there will be no time to look after this detail. This setscrew provides a very delicate adjustment, and is heavily gold-plated to avoid corrosion.

This head protector is manufactured by the Vajen-Bader Co., 120 North Penn St., Indianapolis, Ind., who suggest that mine owners among others take up the question of securing this very important part of every mine equipment before it is actually needed, similar to the advisability of carrying a revolver in Texas—it is not always necessary, but when a man needs it, he needs it bad.—*Mines and Minerals.*

FIG. 2.

Starting Large Gas Engines.

A somewhat daring system is employed at the Snow Steam Pump Works, in starting the 1,000 and 4,000 horse-power gas engine gas-compressors in Cleveland,

Ohio, U. S. A. It cannot be better described than in the Works Manager's own words: "An auxiliary powerhouse is provided, containing small auxiliary gas engines, which, during the night, operate electric generators to supply light for the plant, and supply the storage-battery used for furnishing current for the electric igniters during the day and night. These auxiliary gas engines are also connected to mixture compressors, which compress the proper proportion of natural gas and air (in the proportion of about 1 to 12) into a large tank. Connection is made from this tank to the ends of the cylinders, which are used for starting. The engineer turns this mixture under about 100 lbs. pressure into one end of one power cylinder, which causes the piston to move to the other end. The pressure is then allowed to escape from this end, leaving the cylinder full of mixture at about atmospheric pressure. He then goes to the other end of one of the other cylinders, and admitting mixture pressure to this end, forces the pistons back again to the other extreme position, compressing the mixture in the end of the first cylinder to which it was admitted. He then trips the igniter on this cylinder, which causes an explosion and starts the machine, and upon compression and ignition in the second cylinder to which the mixture is admitted, the reverse stroke is made under power, by which time the other cylinders have been rendered operative on account of drawing in their own gas and compressing same and exploding. Very little trouble is experienced in starting the engines in this way. The mixture tank and its connections are designed to stand easily an explosion-pressure of about 600 lbs.; while, in addition to this precaution, a number of large relief valves are applied to the tank for the purpose of partially relieving internal pressure, should an explosion of this mixture take place in the tank. We question as to whether this method of starting would be permitted by insurance companies within the city limits; but, as we have before remarked, all our work in the gas engine line has been confined to the building of gas engine compressors, which are always located back in the country, and always some distance from cities or populous communities."—*Proceedings British Association,* 1902.

Notes.

Good steam coal will not contain more than eight per cent. or ten per cent. ash. It will take 10⅛ pounds air to burn one pound ordinary coal.

The patented compressed air sweeper now used at the Washington Hotel at Portsmouth, O., excites much favorable comment. The Washington is strictly up-to-date in all respects.

At Claridge's Hotel, in London, on the night of January 9th, Mr. George Westinghouse entertained at dinner a large company of British railway managers, financiers and scientists.

The Pneumatic Signal Co., New York, has been awarded the contract for installing an interlocking plant at Grand Forks, B. C., being a crossing of the G. N. and G. F. and K. R. Railroads.

The Norwalk Mfg. Co., of Norwalk, O., have been incorporated to succeed the Norwalk Foundry & Machine Co. Capital stock, $50,000. Incorporators: W. H. Price, E. A. Stevens and A. M. Beatty.

To calculate the horse power of a windmill, approximately, multiply the area of the slats in the plane of revolution by the cube of the velocity of the wind in feet per second, and divide product by 4,000,000.

To determine the approximate horse power necessary to pump water to a given height by steam, multiply the total weight of water in pounds by height in feet and divide by 16,500. This allows for friction and steam loss.

The Philadelphia Pneumatic Tool Co., of Philadelphia, have issued a pamphlet dealing with "The Care and Use of Pneumatic Tools," of which a copy will be mailed upon application. It is of general interest to the trade.

The air compressor plant of the Castle Creek Mining Co. of Mystic, S. Dak., was totally destroyed by fire. The plant consisted of boilers and engine, as well as air compressor and pump. The loss is $7,000. The machinery will be replaced.

The British gallon of water contains 277.274 cubic inches; the United States gallon of water, 231. There are 7.48 United States gallons in a cubic foot, 6.23 British. A British gallon of water weighs 10.01 pounds; a United States gallon 8.35 pounds.

The Naval Magazine at Iona Island, N. Y., have had a $14,000 appropriation made them for a new compressed air charging station, with pipes and fitting, machine tools for the machine shop and the carpenter shop, and improvements to the old dock.

To keep machinery from rusting dissolve one ounce camphor in one pound melted lard; remove the scum; mix as much black lead with the lard and camphor as will give it an iron color; clean the machinery well; smear with the mixture; after twenty-four hours rub off; clean and polish with soft cloth.

Handsome new cars for the electric railway between Lansing and St. Johns, Mich., have been received in that city, and electric transportation will be furnished shortly. The cars are said to be the finest ever brought into the state, and they are equipped with compressed air reservoirs for propelling them along the streets of the city.

A telescope ladder capable of being extended to a length of 85 feet and worked by means of compressed air was tested recently in Pittsburg, Pa. The ladder can be directed at a particular window in a burning building; a fireman lashed to the end of the ladder is shot up with it, and rescued persons need not clamber down, as the ladder can be quickly lowered with them on it.

Notice is given steamboat and sailing vessel masters that the machinery operating the compressed air siren at the Thimble shoal light station, in Chesapeake Bay, Delaware, was disabled during a fog recently and cannot now be sounded. Repairs will be made to siren as soon as possible, but until they are made fog bells will be struck by machinery in thick and foggy weather to warn vessels of their approach to the shoals.

The New Jersey Pneumatic Crane Company, with a capital stock of $100,000, which it is said will later be increased to several millions, have been organized and papers of incorporation filed in New Jersey through the Corporation Trust Company. The charter of the company is very broad and enables the company to manufacture, buy, sell and deal in pneumatic cranes, air compressors, tool and machinery of all kinds operated by air, electricity, steam and water power.

The Havana Bridge Company, of Montour Falls, has been reincorporated under the name of the General Pneumatic Company, and the capital stock increased to $75,000. The stockholders have elected the following officers:

President, Robert T. Turner; vice-president, C. F. Carrier; secretary, James A. Shepard; treasurer, Frank A. Hatch. The articles to be manufactured are motor hoists and cranes, air compressors, pneumatic hammers and compression riveting machines.

A non-slipping tread for pneumatic motor car tires has been introduced by the Dunlop Company. The thickness of the ordinary tread is somewhat increased. The thickened tread is cut transversely with segmental grooves about ½ in. deep by ¾ in. wide, the grooves occurring at center to center distances of 1¾ in. all round the tread. Although efficient while comparatively new, it remains to be seen how the device will work when worn. It will also probably be found that the tire is not so resilient when fitted with the non-slipping covers.

At the new shop of the Allis-Chalmers Co., near Milwaukee, Wis., the boilers are fed from cisterns outside the room, supplied by artesian wells. The wells are operated by air lifts, 1½ in. air pipes and 6 in. water pipes serving to lift 385 gallons of water per minute through a height of 108 ft. Air pressure of 105 lb. per sq. in. is required to start the flow, which then continues under 80 lb. air supply.

A cross-compound two-stage air compressor supplies air at 100 lb. per sq. in. for driving air tools, hoists, etc., and for the air lifts in the artesian wells as already noted. Its capacity is 1,000 cu. ft. of free air per minute.

The Philadelphia Pneumatic Tool Company has arranged to double the size of its offices in New York by renting additional room in the Singer Building, corner Broadway and Liberty streets.

This is made necessary by the greatly increasing business of this company in and around New York City. An electrically-driven air compressor and a complete plant for testing and exhibiting pneumatic tools of all kinds in operation will be installed.

The New York offices will continue under the management of Mr. W. A. Battey, assisted by Mr. James H. Beaubien.

Air Compressors can not be satisfactorily utilized to operate power drills, running the air direct from the compressor through the pipe line to the drills. A receiver should always be provided at an intermediate point, and, if the line be long, two receivers are advisable, one near the compressor and one at the nearest point available to the drills. At some mines having auxilliary steam power plants, when the boilers are not in use as steam generators the air lines are connected with the boilers, thus largely increasing the storage capacity and rendering more uniform efficiency. When steam boilers are used in this manner the air may be re-heated by keeping a moderate fire underneath the boilers, greatly increasing the expansive force of the air thereby.

The Public Health Committee of the London County Council have just issued a report giving the results of chemical and bacteriological examinations of the atmosphere in the stations, lifts, passages, and tunnels of the Central London Railway, England.

In concluding their report, the committee state that they have been informed that the Central London Railway Company are taking steps to improve the ventilation of the tunnels by installing a large rotary fan at the Shepherd's-bush end, which will be powerful enough to draw out all the tunnel air three times in the three hours during which the traffic is stopped at night. They also state that the company are installing at the Bank station an air compressor which will force compressed air drawn from the street level into the extreme end of the Bank sidings while the trains are in motion and thus purify that part.

A smart and simple instrument is the Evelyn patent bubble clinometer, which consists of a curved tube or vessel, fitted with water or diluted spirits in which floats a small bubble of compressed air. Adjacent to the tube and concentric with its outer edge is the graduated arc of a circle. When the air bubble is at the zero point of the graduated arc, the base of the instrument is horizontal or level, and any deviation from the level is marked in degrees by the position of the bubble on the graduated arc. These instruments are invaluable to yachts, especially racing yachts, as they afford the means of ascertaining the comparative stiffness of different vessels. The Hughes "X.Y." station pointer also will be of interest to yachtsmen. This pointer, in addition to the usual three metal arms, possesses the great advantage of having a transparent disc of xylonite, through which all the details of the chart are clearly seen. It is very simple in construction, and less than half the price of the regular station pointer.

William M. Myers, of St. Joseph, Mo., an inventor of that city who has a shop and residence at 2817 Dewey avenue, believes he has studied out a process for making compressed air and liquid air that will reduce their cost and make them available in many more ways than at present dreamed of. W. T. Van Brunt, the newly elected president of the St. Joseph & Grand Island Railway, has become interested in the invention of Mr. Myers and in turn has financially interested E. H. Harriman, the railway magnate, who is enthusiastic over the possibilities.

The new compressor is a simple appliance, a plain, simple air pump, either single or double acting, as desired, by which water is injected at each stroke, thus cooling the interior and water packing the piston, thereby avoiding back leakage and reducing the heat vibrations. By this simple process air can be compressed from ordinary atmospheric pressure up to any desired compaction, even to thousands of pounds per square inch at one stroke in a simple pump without heat.

Mr. H. J. Lake, of Grand Marias, Mich., has received the sole agency, with authority to appoint in Alger, Luce and Schoolcraft counties for the new "Kant Clog" nozzle and Compressed Air Sprayer. The new invention is practical in every way

and can be brought into a number of uses, the principal one being that of spraying plants, vegetables and fruit trees with solutions. In this alone the farmer will have found a prize, as the sprayer works automatic when once filled with compressed air, is light to handle and can be operated by a child. Besides the above, the sprayer can be used to whitewash the interior of buildings, wash windows and carriages or in fact anything where a stream of water or solution is demanded. The cost of the sprayer is small when its usefulness is considered, as no farm is complete without one or more, and they cost but $5 each. They are the most complete outfit for spraying paris green that has ever been placed on the market.

The Kenefick-Hammond contracting company has opened headquarters at Aurora, Mo., and have a large force of men and horses to start the construction work on the White River road from there south.

About fifty expert men have arrived in Aurora and are awaiting orders to leave for the south, where they are to begin work on the two great tunnels on the line of the White River road, the first near Reed's Spring, about four and one-half miles southeast of Galena, and the other not far south of White River.

An electric light and compressed air plant is to be established at the mouth of each tunnel for furnishing air for the drills and light for the workmen. A large number of Ingersoll-Sergeant air drills are to be used on the contract, and tons of dynamite.

Work will also be commenced as soon as possible upon the big steel bridge to be built across White River, the structure to be 1,300 feet in length and eighty feet above the water level.

The *Scientific American* writes that a number of tiny engines have been constructed at different times, but doubtless the smallest which has yet been built which is actually operated was recently completed by Mr. A. G. Root, of Danbury, Conn. It stands on a piece of metal just the size of an American 10-cent piece, the materials of which it is made being gold, silver, brass and steel. The largest part of the engine is less than a half-inch in length, the fly-wheel being 7-64 of an inch in diameter, while the main shaft of steel is but 5-16 of an inch in length. The band of the fly-wheel is of gold. The total weight of the engine without the base is but three pennyweights, and its total height is less than a half-inch. In making the various parts and putting them together it was necessary to use a magnifying glass on account of the delicacy of the work, yet the engine runs perfectly, compressed air being used for power applied through a tiny tube. As long as the air supply is maintained, it continues in motion. The horse power developed is so small that it cannot be estimated.

At a meeting of the Yorkshire College Engineering Society, Leeds, England, on Monday, Feb. 9th, a paper on "Pneumatic Tools" was read by Mr. J. R. Kelly, who dealt with this recent and important development of engineering principally from a practical standpoint. He claimed the advantages of portability, absence of skilled labor for operating, absence of risk, increase of output as compared with manual labor, and low cost as compared with fixed tools doing the same work. He explained the construction and action of pneumatic hammers and drills, and gave particulars of remarkably good work performed by these tools, citing the repair of the steamship Etruria as an instance of time and labor saved by their use. He was careful to explain that he did not consider pneumatic riveters would displace fixed hydraulic riveters where work could be taken to the machines. The lecture was illustrated by slides and tools in operation. The paper was warmly applauded, and at the close of a discussion which followed a hearty vote of thanks was accorded to Mr. Kelly.

The *Brooklyn Times* writes that the Brooklyn tunnel is still in an incipient stage. The only work done thus far has been the sinking of a shaft at the Battery, Manhattan, but the excavating will not begin until the necessary steel has arrived. The Rapid Transit Commission at the last meeting gave the contractor permission to sink two shafts in Brooklyn, one at the foot of Joralemon street and the other near Henry street. Compressed air drills will be installed and the work of completing the Brooklyn end of the tunnel to Flatbush avenue will be rapidly pushed.

Principal Assistant Engineer Rice, of the Rapid Transit Commission, said that the work of tunnelling under the river will not commence until the early spring. Most of this will be through solid rock according to the soundings made by the engineers. This work will require special machinery and drills, which are now being manufactured and will not be ready until some time in May.

The work on this part of the tunnel will start simultaneously from both sides of the river. The men will work toward one another and it is expected that they will meet and the tunnel will be joined in the center of the river. This work, the engineers say, will take about two years. The burrowing of the land ends of the tunnel will be accomplished in less than half that time, as there will be no difficult engineering problems to solve and the work is simply that of excavating.

Allis-Chalmers Company will on May 1st, 1903, remove their general offices from the present location in the Home Insurance Building to the New York Life Building, corner of La Salle and Monroe streets, Chicago.

This move is only another indication of the progressive spirit which prevails in the management of this strong industrial. The Allis-Chalmers Company has for the past two years been expending enormous sums of money in betterments at their various works in Milwaukee, Scranton, and Chicago, so as to give their customers the best possible service in point of economy and quick deliveries.

The new offices of the Allis-Chalmers Company will provide ample space for the various sales departments and general business offices, which will be inducive of the best possible service to their trade.

To give a fair idea of the scope of the business enjoyed by the Allis-Chalmers Company, will mention that during the past two months orders for either engines, mining machinery, rock crushing machinery, saw mill machinery and flour mill machinery were booked from every State in the Union, besides the following foreign countries: England, South Africa, Mexico, Canada, Chile, Central America, Brazil, West Australia, Turkey, Finland, Yukon Territory, Belgium, British Columbia, Bolivia, Hawaiian Islands, Peru, Alaska, China, Philippine Islands.

The Chicago Pneumatic Tool Co., of Chicago, state that if the amount of business transacted for the month of February is any indication, the year 1903 will indeed be the banner year of the pneumatic tool business in their experience. They state that the orders received for the month show an increase of over 50 per cent. over those received for the same month in the preceding year, and this immense influx of business has necessitated the removal of their plant at Aurora, Ill., to Cleveland, and its consolidation with the plant there in order to adequately fulfill requirements. Even with this increase in facilities they are obliged to work both night and day forces at their factories.

The following are a few of the installations of pneumatic machinery made during the week ending Feb. 28th:

Moran Bros. Co., Seattle, Wash.

Wm. Cramp & Sons' Ship and Engine Building Co., Philadelphia, Pa.

International & Great Northern Ry., Palestine, Tex.

Messrs. J. A. Yates & Co., of Birmingham, Ala., writes COMPRESSED AIR as follows:

"We notice in some of the articles referring to explosions in "Air Receivers" that in nearly every case the cause is attributable to the use of low grade volatile oils for lubricating the air cylinders, and presuming that all such cases brought to your attention will prove of interest to you, we wish to cite an instance which was brought to our notice very recently in this county. In this case we found that common, unrefined black oil was used in the air cylinder, and that the compressor was being run at a high speed and sustaining a steady pressure in the air receiver of something over 80 pounds. This imprudence resulted in an explosion taking place in the air receiver, blowing it to atoms and killing the engineer in charge of the plant. We do not think that you can put too much stress on the condemnation of this practice of using low test oils, and we note with pleasure that they are frequently calling attention to such errors in the columns of your paper, COMPRESSED AIR, anything which may arise in our work here, and which will be of any interest to you, we will gladly bring to your attention."

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U. S. PATENTS GRANTED JAN. 1903.

Specially prepared for COMPRESSED AIR.

717,642. AUTOMATIC RELIEF-VALVE FOR PNEUMATIC SEED-COTTON DISTRIBUTERS. George W. Wade, Oakforest, Tex. Filed Jan. 6, 1902. Serial No. 88,653.

A pneumatic flue of the class described having an air-inlet opening, in combination with a valve to open and close said opening, a weight, a flexible element connecting the weight to the valve, to normally maintain the valve in a closed position, and an eccentrically-mounted revoluble direction element engaged by said flexible connecting element, for the purpose set forth.

717,688. GAS AND AIR REGULATING VALVE. Elmer E. Kerns, Bradford, Pa. Filed May 19, 1902. Serial No. 107,992.

The combination with a valve-casing provided with an inlet and an outlet opening, and a valve-plug rotatably mounted within said casing and provided with graduated openings adapted to be brought into register with the outlet-opening of the valve-casing; of a mixing-chamber communicating with the outlet-opening of the valve-casing and provided with an air-inlet opening, an air regulating valve for said mixing-chamber, and a connection between the air-regulating valve and the valve-plug, whereby when the latter is operated to regulate the flow of gas through the outlet-opening, the air-regulating valve will also be operated to control the admission of air to the mixing-chamber.

717,760. AIR-PUMP. Abner A. Phipps, New York, N. Y. Filed Feb. 1, 1902. Serial No. 92,115.

The combination with the pump having the usual piston and discharge, a valve-seat in the receiving end of said discharge, of a valve carried by the piston to fit the seat, and means as the threaded parts in the discharge and on the valve-stem to secure the valve in closed position.

The combination with the pump having the customary piston provided with a valve, a valve-seat in the receiving end of the discharge, of a limiting device to prevent the valve parts from coming together during the reciprocation of the piston.

717,926. PNEUMATIC GRAIN-ELEVATOR. Julius C. Rieth, Sandwich, Ill. Filed Aug. 5, 1902. Serial No. 118,478.

A device of the kind described comprising a winged revoluble cylinder, a passage ar-

ranged adjacent to and parallel with the cylinder, the spaces between the outer edges of the wings corresponding to the width of the passage, and the wings being adapted to register with the sides of the passage to form a closed conduit.

717,965. PNEUMATIC DRIVER AND CUSHION FOR LOOM-SHUTTLES. John C. Blundell, Boston, Mass., assignor to Pneumatic Textile Machinery Company, Jersey City, N. J., a Corporation of New Jersey. Filed Nov. 30, 1901. Renewed Dec. 13, 1902. Serial No. 135,164.

An apparatus of the character described, a cylinder, a source of compressed air, an inlet for the compressed air to the cylinder, a valve controlling said inlet, mechanism operated by compressed air for driving the shuttle, and means independent of said air-inlet-controlling valve for regulating the escape of air from the cylinder and thereby cushioning said driving mechanism on its return stroke.

717,996. RAILWAY-BRAKE. Georges Houplain, Paris, France. Filed June 30, 1902. Serial No. 113,801.

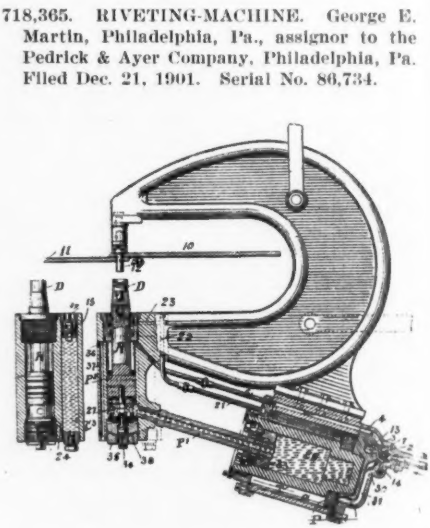
An air-brake, the combination of a piston and its rod, a lever for controlling the brake, two levers and one end of the lever being pivoted to the lever and one end of the lever being pivoted to the rod and the other ends of said levers being pivoted to each other and cheeks having recesses to normally receive one end of the lever and hold the same perpendicular to the rod when the piston is in its idle position and also to put said lever into alignment with the rod when the same is operated to thereby multiply the movement of the rod at the commencement of the brake action and bring the brake-blocks into contact with the wheels by a very slight movement of the piston.

718,395. PNEUMATIC STACKER. Thomas W. Slutz, Crowley, La. Filed April 11, 1902. Serial No. 102,341.

718,424. HYDRAULIC APPARATUS. Alexander S. Cardella, Chicago, Ill., assignor of one-half to William H. Wallis, Chicago, Ill. Filed Jan. 17, 1902. Serial No. 90,117.

A hydraulic apparatus, the combination with a siphon, of a reservoir into which the longer end of the siphon empties, an elevated tank connected to said reservoir, a pump connected to the larger end of the siphon and to the reservoir, operating to create suction upon the longer end of said siphon, and to force air into the reservoir, and suitable means for closing the communication between the pump and the siphon and the pump and the reservoir.

718,365. RIVETING-MACHINE. George E. Martin, Philadelphia, Pa., assignor to the Pedrick & Ayer Company, Philadelphia, Pa. Filed Dec. 21, 1901. Serial No. 86,734.



A riveting-machine, the combination of a power-cylinder provided with a differential power-piston constructed with a hollow trunk for containing a liquid, a fixed hollow spindle communicating therewith and with the riveting piston-cylinder; a minor piston-cylinder communicating independently with the air-pressure and with the riveting-cylinder, and a check-valve device with means for operating the same located between the riveting and the minor cylinder, for the purpose set forth.

718,450. SUBMARINE BOAT. Clarence B. Gillette, Winsted, Conn. Filed Aug. 6, 1901. Renewed Nov. 24, 1902. Serial No. 132,578.

A submarine boat having suitable propelling means, means for regulating the reserve buoyancy, wings on opposite sides connected at their forward ends to a horizontal shaft that extends transversely near the middle of the boat, and pneumatic mechanisms for rotating the shaft and giving the wings a vertically-rotative movement to such positions that they will, as the boat moves, counteract the reserve buoyancy, substantially as specified.

718,533. INSTANTANEOUS RELEASE FOR THE AIR-BRAKE CYLINDERS OF ENGINES AND TENDERS. Thomas A. Seery, Keene, N. H. Filed April 4, 1902. Serial No. 101,326.

An air-brake system, the combination with the brake-cylinders for the engine-driver brakes, a main reservoir, an auxiliary reservoir, a triple valve, of means to instantly release the pressure in the said brake-cylinders, independently of the operation of the brakes on the cars, said means comprising a supplemental release-valve connected to the said brake-cylinders, and means carried entirely by the engine and under the control of the engineer to operate said release valve by the main-reservoir pressure.

718,657. AIR-INLET VALVE. Herbet S. Renton, Brooklyn, N.Y., assignor of one-half to Jacob Manneschmidt, Jr., Brooklyn, N. Y. Filed Aug. 4, 1902. Serial No. 118,228.

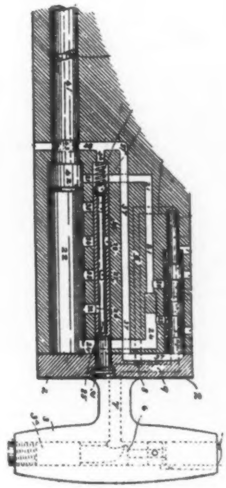
An air-inlet device comprising a casing having an air-inlet opening and a valve-seat, and a valve pivoted on an axis intermediate of the length of its valve-faces and having a greater area in the portion of the valve which moves outwardly to close the valve than in the portion of the valve which moves inwardly to close the valve and having its weight disposed so that it will normally assume an open position and being so balanced in open normal position that the portion of greater area extends inwardly away from the air-inlet opening and the portion of lesser area extends outwardly toward the air-inlet opening, to provide in normal position of the valve an opening through the valve-seat which is practically free and unobstructed.

718,740. PNEUMATIC-TUBE SYSTEM. Kenneth E. Stuart, Philadelphia, Pa. Filed May 31, 1902. Serial No. 109,603.

A pneumatic-tube system consisting of a series of station-heads provided with selective discharge appliances whereby an incoming carrier is automatically delivered at the station or shunted into the conduit leading to the next station in accordance with the character of selective appliances on such carrier, in combination with a series of tube-conduits connecting the series of stations in an endless circuit, means for inserting carriers at the respective stations, a suction-conduit connected with one of the tubes, an opening into the tube for admission of air adjacent to the suction-conduit connection and a flap-valve in the conduit between the suction and air-admission connections adapted to open under the impact of a carrier.

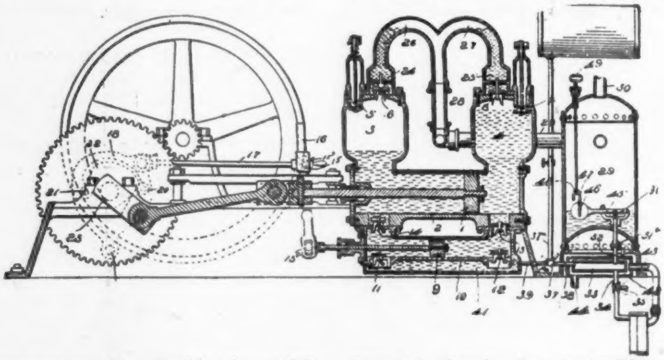
718,911. TRIPLE VALVE FOR AIR-BRAKES. Niels A. Christensen, Milwaukee, Wis. Filed April 15, 1901. Serial No. 55,842.

719,027. PNEUMATIC HAMMER. William T. McCook, Richmond, Va. Filed Jan. 30, 1902. Serial No. 91,825.



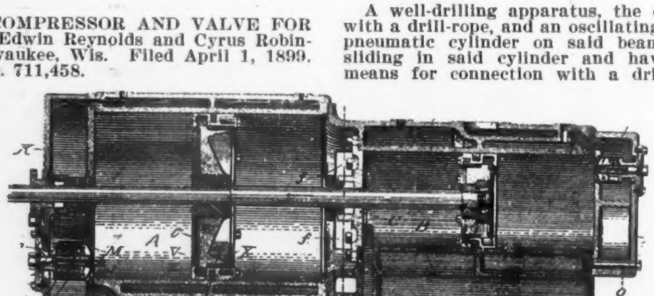
An automatic hammer having an inlet-passage for the admission of the motive fluid, a pressure-chamber, a hammer in the pressure-chamber, a valve-chamber intermediate and in communication with the inlet-passage and the pressure-chamber, a valve in the valve-chamber to control the flow of the motive fluid between the valve-chamber and the pressure-chamber, and an intermediate chamber in communication with the valve-chamber and connected with the pressure-chamber by a series of ports or passages which enter the pressure-chamber at points along its length, a check-valve controlling the connection between the intermediate chamber and the valve-chamber, and adjustable means located in the intermediate chamber whereby the check-valve may be put in communication with the pressure-chamber through any one of the series of ports or passages entering the latter.

719,127. AIR-COMPRESSOR. William M. Myers, St. Joseph, Mo. Filed Dec. 14, 1901. Serial No. 85,953.



An air-compressor, the combination with two vertically-arranged compression-chambers in which liquid is adapted to be reciprocated, a horizontal chamber in communication with said chambers, a horizontal reciprocating piston in said chamber, a smaller horizontal chamber below the said chamber and in communication therewith to supply liquid to the compression-chamber, a piston mounted so as to reciprocate in said smaller horizontal chamber to force the liquid into the pump-chamber, an adjustable reciprocating lever connected with said last-mentioned piston, a rod operated by an eccentric adjustably connected with said lever so as to limit the throw of the piston, and a motive power for operating the lever and the horizontal reciprocating piston, of a tank to receive the compressed air and means to cool the liquid before it is supplied to the small horizontal chamber.

719,142. COMPRESSOR AND VALVE FOR SAME. Edwin Reynolds and Cyrus Robinson, Milwaukee, Wis. Filed April 1, 1899. Serial No. 711,458.



An air-compressor or the like, the combination of a low-pressure cylinder, provided with a suitable air-intake; a head secured to said cylinder and formed with an air-receiving chamber; eduction-valves mounted within said chamber and closing ports leading into the cylinder; a high-pressure cylinder; a receiver G connecting the said air-receiving chamber with the intake end of the high-pressure cylinder; a chambered head for the opposite end of said high-pressure cylinder; eduction-valves mounted therein for controlling the ports communicating with the high-pressure cylinder; a piston-rod working in said cylinders; a piston mounted in each of said cylinders, and connected to the rod; and induction-valves carried by said pistons.

719,279. PNEUMATIC TRANSFERRING MECHANISM FOR CIGAR-MACHINES. Oluf Tyberg, New York, N. Y., assignor to Rufus L. Patterson and George Arents, Jr., New York, N. Y. Filed Aug. 1, 1901. Serial No. 70,467.

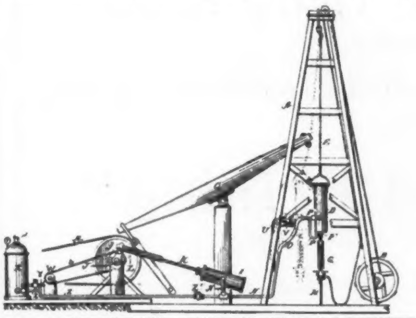
719,308. PNEUMATIC STRAW-STACKER. Charles F. Dammeier, Metz, Iowa. Filed June 6, 1902. Serial No. 110,439.

719,370. PNEUMATIC BALANCING ROPE-TENSION ATTACHMENT. Harry W. Rank, McDonald, Pa. Filed June 29, 1901. Serial No. 66,559.

A well-drilling apparatus, the combination with a drill-rope, and an oscillating beam, of a pneumatic cylinder on said beam, a piston sliding in said cylinder and having a rod, means for connection with a drill-rope, the cylinder being filled with air on the front side of the piston, whereby the latter reciprocates as the beam oscillates and the drill-rope slackens and tightens.

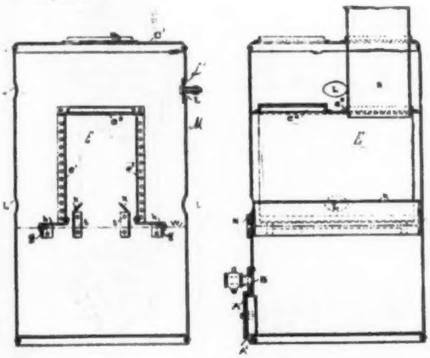
719,371. PNEUMATIC WELL-DRILLING APPARATUS. Harry W. Rank, McDonald, Pa. Filed July 6, 1901. Serial No. 67,288.

A pneumatic well-drilling apparatus, the combination, with a suspended drill-cylinder having an air-port at bottom and another near the bottom, said ports being provided



with valves seating in opposite directions, as specified, of a slidable piston arranged in such cylinder and whose rod is adapted for connection with drilling mechanism proper, an air forcing and suction apparatus including a cylinder and a piston reciprocating therein, and a pipe which connects the last-named cylinder with the first-named or drill cylinder and is branched to connect with the two ports of the latter, and means for reciprocating the piston of the cylinder of the forcing and suction apparatus.

719,395. WASHER FOR SAND-BLAST APPARATUS. Ambrose G. Warren, Philadelphia, Pa., assignor of one-half to J. W. Paxson Company, Philadelphia, Pa., a Corporation. Filed Mar. 30, 1901. Serial No. 53,665.



An apparatus for separating dust from air, consisting of a suitable closed casing having air inlet and discharge openings at or near the top thereof, laterally-disposed partition-walls e^1 e^2, with a cover-plate e^3 forming a central chamber into which dust-laden air is conveyed, a tubular inlet-pipe S forming a conduit or passage-way between the air-inlet and said partition-chamber, a laterally-arranged perforated plate at the base of each partition-wall, and vertically-arranged deflecting-plates within said chamber, extending below the perforated plates.

719,397. DRY ORE-SEPARATOR. Robert E. Waugh and Eugene Waugh, Denver, Colo., assignors of four-sevenths to James H. McShane, Felix J. McShane, Henry J. Paschel, and Clemont L. West, Omaha, Neb. Filed Sept. 21, 1901. Renewed May 27, 1902. Serial No. 109,199.

A dry ore-separator, the combination with a main frame, of an apron-frame mounted thereon and provided with an air-chamber, an endless traveling apron mounted on the apron-frame and provided with electromagnets located adjacent the inner surface of the apron which is arranged to close the air-chamber, and means for introducing air under pressure to the air-chamber, the apron fabric being such as to allow the air from the chamber to pass therethrough for the purpose set forth.